## Journal which deals with research, Innovation and Originality

**Table of Content**

## Message from Assistant Editor In Chief

Let me first of all take this opportunity to wish all our readers a very happy, peaceful and prosperous year ahead.

This is the second issue of the first Volume of International Journal of Engineering Research and General Science. A total of 7 research articles are published and I sincerely hope that each one of these provides some significant stimulation to a reasonable segment of our community of readers.

In this issue, we have focused mainly on the technology with the recent research that can have a great impact in our society through conceptual ideas implementation approach. As such, we encourage submission of more recent and relevant ideas and research papers from our readers too, which will be published in the upcoming issues.

Author's response for this issue was really inspiring for us. We received many papers in this issue than previous one but our technical team and editor members accepts very less number of research papers for the publication. We have provided editors feedback for every rejected as well as accepted paper so that authors can work out in the weakness more and we shall accept the paper in near future. We apologize for the inconvenient caused for rejected Authors but I hope our editor feedback helps you discover more horizons for your research work.

I would like to take this opportunity to thank each and every writer for their contribution and would like to thank entire International Journal of Engineering Research and General Science (IJERGS) technical team and editor member for their hard work for the development of research in the world through IJERGS.

Last, but not the least my special thanks and gratitude needs to go to all our fellow friends and supporters. Your help is greatly appreciated. I hope our reader will find our papers educational and entertaining as well. Our team have done good job however, this issue may possibly have some drawbacks, and therefore, constructive suggestions for further improvement shall be warmly welcomed.

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# PROPERTIES OF RAMIE AND ITS BLENDS

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**Abstract**— Ramie is recognized as the strongest of all natural bast fibres in the world which is known as riha in Assam. It is a perennial shrub of the urticacease family yielding fibre from the bark of the canes which provides excellent raw material for blending with the natural and synthetic fibres. It was found that the full grown plant attains a height of about 5-8 feet and diameter of stem 5.0-3.0 cm at three different levels, viz. bottom and top. The morphological characteristics and chemical analysis showed their suitability as good textiles materials. The physical properties of Ramie fibre exhibited high tenacity, high luster and brightness. It has resistance to heat, light, acid and alkali etc. The fibre materials were capable of producing excellent blended fabrics and its position as substitute for cotton is unchallenged. Ramie blended with different types of silk showed good results, but 50:50 blends showed the best result than 60:40 blends. The breaking laod of 50:50 blends ranged from 131.75 – 189.16 lb for different type of silk. Therefore, blending of ramie with different silk with different blend proportions offers excellent scope for producing a variety of materials for different uses.

**Keywords**— Ramie, Synthetic Fibers, Cotton, Textiles Materials

## Introduction

Ramie, one of the oldest textile fibre of plant origin ruled the textile world as king of natural fibres. Its popularity in the textile world is limited due to the difficulty in degumming and lack of knowledge of mechanical processing. Increasing ecological consciousness has accelerated interest in ramie originating from plants that are safe, biodegradable and recyclable. Ramie is highly adorned for its luster, strength, excellent microbial resistance and valuable hygienic properties. Some of the demerits are encrusting gummy materials and its cohesiveness. If the apparent demerits can be masked, an excellent diverse range of product can be engineered by exploiting the intrinsic properties of ramie.

The demand for ramie fiber is mainly felt in the fields of blending with other fiber. Ramie can be blended with cotton, flax, wool, polyester, acrylic and silk of all types.

Based on the demand of the ramie fiber, a detail study were made on possibility of utilizing ramie fibre with different silk waste with the following objective:

To establish the feasibility of blending ramie with different silk waste.

To assess the desired physical properties of the blended yarn.

Product development.

## Materials & Methods

Decorticated Ramie fiber was collected from Ramie research station, central Research Institute for jute and allied fibers (CRIJAF)Sorhhog, Assam

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**Fig. 1. Ramie Plant**

**Methods:**

**Degumming of Ramie**: Decorticated ramie fiber was degummed with four different concentrations (0.5%-2%) at different time period 1-2.5h at 100°. After degumming fibres were washed thoroughly & neutralized with dilute acetic acid. Fibers were than hydro extracted & dried. After degumming, fibres were bleached with 1% hydrogen peroxide.



**Fig 2.**

A) Bark of ramie

B) Decorticated ramie fiber

C) Degumming ramie fiber

**Chemical analysis :**      The proximate chemical analysis of the fiber was carried out by standard methods of the Technical Association of Pulp & papers Industry, (4).

**Fiber Morphology:** The bleached fibers were observed under the microscope fitted with micrometer scale for measurement of the length, diameter, wall thickness & lumen width.

**Blending:** Blending was done in carding stage and yarns were spun on silk spinning machines. Prior to testing, the blended yarns were conditioned to moisture equilibrium and tested in the laboratory following ASTM standards (5).

**FINDINGS**

**Fiber properties:**

**Table 1: Morphological properties of the ramie fiber**

| | Properties | |
|---|---|---|
| 1. | Fiber length (L) mm | |
| | Maximum | 60.40 |
| | Minimum | 30.00 |
| | Average | 40.00 |
| 2. | Fiber diameter (D) μm | |
| | Maximum | 20.00 |
| | Minimum | 8.00 |
| | Average | 10.00 |
| 3. | Cell wall thickness (W) μm | 2.80 |
| 4. | Lumen width average (d) μm | 12.80 |

The morphological characteristics of ramie fiber were examined & presented in Table 1. The maximum fiber length was found to be 60.40mm, while the average length was found to be 40.00mm. So as the maximum diameter of the fiber was observed 20μm and average diameter was found to be 10μm. cell wall thickness & lumen width were (2.80 & 12.80μm) respectively.

**Table 2. Chemical constituent of the ramie fiber**

| | Particulars | Decorticated ramie | Degummed ramie | Bleached ramie |
|---|---|---|---|---|
| 1. | Moisture content(%) | 6.97 | 7.51 | 8.3 |
| 2. | Ash content (%) | 1.25 | 0.69 | 0.46 |
| 3. | Lignin (%) | 9.25 | - | - |
| 4. | Pentosan (%) | 4.80 | 1.01 | 0.9 |
| 5. | Cellulose (%) | 70.10 | 84.1 | 87.2 |
| 6. | Fat & wax(%) | 0.6 | 0.4 | 0.2 |
| 7. | Hemi cellulose | 9.8 | 3.4 | 2.3 |

The chemical constituent of ramie fiber was analyzed and data were presented in Table 2. The moisture content of bleached fiber was more (8.3%) where as ash content of raw fiber was found to be more in case of decorticated fiber. It was interesting to note that the lignin was completely removed in case of degummed and bleached fiber which may be due to proper degumming of the fiber (6). From the table it was seen that the pentosan contents were decreased in case of degummed and bleached fiber, while the percentage of cellulose contents was increased.

**Scanning electron microscopic study of**                                                                                          **ramie fibre:**



**Fig. 3. Decorticated ramie fibre**



**Fig. 4. Degummed ramie fibre**



**Fig. 5.Bleached ramie fibre**

**Scanning electron microscopic study of ramie fibre :**

The surface morphology of ramie fibre was examined under a scanning electron microscope and are shown in fig 3, 4, 5. The gummy substance was seen in the raw decorticated ramie fibre, where as the surface of the degummed and bleached ramie was found smooth.

**Table 3. Physical properties of the fiber**

| Property | Ramie | Muga | Eri | Mulberry |
|---|---|---|---|---|
| Denier | 3.0 | 4.30 | 5.10 | 1.02 |
| Average fiber length (mm) | 40 | 80.00 | 90.0 | 98 |
| Mean breaking load (g) | 30.09 | 15.48 | 15.50 | 4.10 |
| CV% of B load | 9.0 | 13.0 | 10.8 | 20.0 |
| Tenacity (g/d) | 10 | 3.60 | 3.10 | 3.6 |
| Mean breaking elongation (%) | 4.5 | 29 | 24 | 20.0 |
| CV% breaking elongation | 20.5 | 18.4 | 11.2 | 30.4 |
| Moisture regain (%) | 17.5 | 13.2 | 15.18 | 18.2 |
| Density(g/cc) | 1.5 | 1.8 | 1.38 | 2.3 |

Fiber properties of ramie, muga, mulberry and eri silk used for the blended yarns were studied and presented in the Table 3. the highest denier was found for eri silk, which was 5.1 and the lowest denier for mulberry silk which was 5.1 and the lowest filament denier for mulberry silk which was 1.02 the lowest breaking load was found (4.1g) for mulberry silk and highest breaking load for ramie fiber (30.09) followed by eri and muga silk (15.50 and 15.48 g) respectively.

It was observed from the Table that breaking elongation of muga was more (29%) as compared to other three fibers. Tenacity of the fiber was also calculated from its breaking load and denier and presented in the Table. The tenacity of the ramie fiber was found to be the highest (10g/d) followed by eri, muga and mulberry (3.1 g/d, 3.6 g/d and 3.6 g/d) respectively.

**Yarn Properties**

**Count and TPI of ramie blended yarns:**

The count and TPI of ramie blended yarns are presented in Table 4. The highest yarn count (12) was found in case of yarns blended with ramie/mulberry. The count of other blended yarns was (6.22 and 8.15) for ramie/muga and (5 and 5.72) for ramie/eri respectively. From the Table, it is clear that as the ramie proportion is increased in the blends, the count of yarn decreases, which makes the yarn thick. This is due to the highest denier of ramie fiber.

The lowest TPI was found in case of ramie/eri blend, which was (16 and 18.5). This may be due to the highest denier of raime and eri fiber. The TPI of ramie/mulberry blend (23.75 and 25.45) was found to be the highest followed by ramie/muga blend (20.39 and 17.75) respectively.

**Breaking strength, elongation per cent of ramie-blended yarns:**

The breaking strength and elongation per cent of ramie-blended yarns are also given in Table 4. It is clear from the Table that the sample of 60:40 blends showed higher breaking strength than 50:50 blends, which is due to the higher content of ramie fiber in the blend. As the ramie proportion in the blend is increased breaking strengths of the fiber increases. The breaking strength of ramie/eri blends were found to be (189.16 and 210.75) followed by ramie/muga (131.75 and 186.3) and ramie/mulberry (120.50 and 167.45) respectively. The higher breaking strength of ramie/eri blend may be due to higher denier of ramie and eri fibres.

The elongation per cent of ramie/mulberry blended was found to be higher than other two blends, (9.3 and 10) and (7.9 and 8.6) for ramie/muga and ramie/eri respectively. The lower elongation per cent of the blended yarn may be due to the stiffness and the higher denier of ramie/muga and ramie/eri fibres.

**Evenness of ramie-blended yarns:**

The unevenness of yarns in the three blends was observed and and recorded in the Table 4. The unevenness per cent of blended yarns was found to be higher (16.10%) in case of ramie/eri blends and lowest (8.50) for ramie/mulberry blended yarns. The 50:50 blend shows less U% than 60:40 blended fiber. The unevenness of silk depends on the hand of the reeler as well as the removal of sericin during cooling and reeling. If the cocoon gets uniform temperature in cooking, then less unevenness can be expected.

**Table 4 : Physical properties of Ramie blended yarn**

| Properties | Blend composition | | | | | |
|---|---|---|---|---|---|---|
| | R.Mu* | | R.Mul* | | R.E* | |
| | 60-40 | 50-50 | 60-40 | 50-50 | 60-40 | 50-50 |
| Count | 8.15s | 6.22s | 10.95s | 12.0s | 5.72s | 5.0s |
| TPI | 17.75 | 20.39 | 23.75 | 25.45 | 18.50 | 16.00 |
| Breaking load (lb) | 186.30 | 131.75 | 167.45 | 120.50 | 210.75 | 189.16 |
| CV% of breaking strength | 9.10 | 8.34 | 10.75 | 11.53 | 10.04 | 7.34 |
| Breaking elongation (%) | 9.30 | 10.00 | 10.00 | 12.00 | 7.90 | 8.60 |
| CV% of elongation | 8.00 | 11.30 | 15.00 | 9.30 | 10.40 | 13.20 |
| Unevenness (U %) | 14.00 | 12.10 | 10.10 | 8.80 | 16.10 | 13.98 |
| CV% | 9.30 | 8.40 | 8.50 | 8.60 | 8.00 | 10.20 |

* **R.Mu** – Ramie/Muga, **R.Mul**- Ramie/Mulberry, **R.E**. – Ramie/Eri



**Fig. 6**

A) 100% ramie yarn

B) Ramie/mulberry blended yarn

C) Ramie/muga blended yarn

**Preparation of fabric:**

Plain weave fabric were prepared by using different blended yarns and based on fabric texture some of the garment were prepared.

**Product of ramie blended fabric Fig-7**





## Conclusion

Both degummed and bleached ramie shows a definite improvement of fibre characteristics, which can be used to blend with different fibres in different processing system. Considering all the physical tests, the 50:50 blend proportion shows better result than 60:40 blends, which is required for clothing materials. From the aforesaid, it can be inferred that both proportions can be used for producing the blended yarn. Blending of ramie with different silk fibres offers excellent scope for producing a variety of materials for different uses. Apart from these blend proportions, different blend proportions can be tried with silk & other fibers for different end uses.

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# SOLAR POND TECHNOLOGY

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   **Abstract**: Had you ever thought of storing  the solar thermal power without any expensive solar storage devices? .Can't we generate solar thermal energy in the form of low  grade heat of 70-80.c with 20.c ambient temp .Yes  this paper suggests a solution of storing the solar energy only  by constructing  a simple pool of salt water ,isn't it amazing?. Thus  a solar pond is a pool of salt water which serves as the solar energy collection and sensible heat storage.

  The solar ponds made a tremendous progress in the last thirty years . This paper also mainly reviews the basic principles of the solar pond and the problems encountered in its operation and its maintenance. Here we also discuss the factors that enhance  the heat storing capacities and also the factors that influence the technical and the economical viability of the solar ponds.

 **Keywords**: solar ponds, solar energy collection, renewable energy, solar energy storage, economical viability.

## INTRODUCTION:

Energy is an important input in all sectors of any country's economic growth**.** The standard of living of a given country can be directly related to per capita energy consumption.

Due to the rapid increase in population and standard of living of human beings, there is problem of energy crisis. The supply of oil will fail to meet the increasing population demand. Hence an alternative energy source had to be chosen to meet the future energy demands.

Currently a number of alternative energy sources and the method of abstracting the energy had been discovered .Among the most widely distributed and clean renewable energy resources ,the solar energy is one of the effective solution to environment pollution and fossil fuel shortage. Solar energy is an abundant and renewable energy source. The annular solar energy incident on the ground in India is about 20,000 times  the current electrical energy consumption. Hence a very little amount of solar energy is sufficient to meet the major energy demands , particularly in the tropical lands. But the use of solar energy has been very limited. This is because Solar energy  is the  time dependent and intermittent energy resource. And also  mainly solar energy is the diurnal energy resource. Hence the main challenge laying here  is storing the solar energy to meet the energy needs.  Hence energies must be collected in large areas with high initial investment .These solar energy storing systems must take care of collecting solar energy at cloud day and during winter times .They should posses the efficacy of storing energy at night times in Oder to supply the energy when required in uniform manner. This may result in further increase in total capital cost of building such systems. One among the best ways to overcome this problem is to use large body of water for collecting and storage of solar energy. This concept is called SOLAR POND.

## PRICIPLE OF OPERATION AND DECRIPTION OF A SOLAR POND:

A solar pond is a mass of shallow water about 1 or 2 metres deep with a large collection area ,which acts as a heat trap. It contains dissolved  salts to generate a stable density gradient . Part of the incident solar radiation entering the pond surface is absorbed throughout the depth and the remainder which penetrates the pond is absorbed at the black bottom. If the pond were initially filled with fresh water , the lower layers would heat up, expand and rise to the surface. Because of the relatively low conductivity ,the water acts as an insulator and permits high temperature (over 90℃ ) to develop in the bottom layers . At the bottom of the pond , a thick durable plastic layers liner is laid. Materials used for liners include butyl rubber, black polyethylene and hypalon reinforced with

nylon mesh. Salts like magnesium chloride, sodium chloride or sodium nitrate are dissolved in the water , the concentration varying from 20 to 30 percent at the bottom to almost zero at the top.
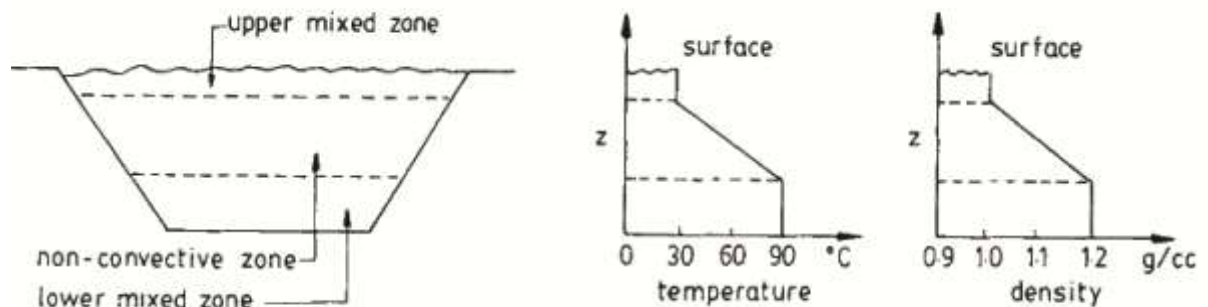


**Figure 1.** Different zones in a solar pond.

. In the salt-gradient ponds , dissolved salt is used to create layers of water with different densities-the more salt, the denser water .Thus a solar pond has three zones with the following salinity with depth :

1) surface convective zone (0.3-0.5m),with  salinity<5% concentration

2)Non-convective zone(1-1.5m , salinity inc with depth

3)storage zone (1.5-2m , salt=20%)

The  Non-convective zone is much thicker and occupies more than half the depth of the pond. Both the concentration and the temp increase with the depth in it. It mainly serve as a insulating layer and reduces the heat transfer. A some part of this zone also acts as thermal storage. The lower zone is the storage zone. Both the concentration and temp are constant in this zone. It is the main thermal storage medium. The deeper the zone. The more is the heat stored. The lowest zone traps heat energy for longer periods. The capacity to store heat for long periods is the chief advantage of solar ponds. Even in the cloudy days and in the ice covered regions the energy can be stored , since the salt water near the bottom  heats up and  expands. However  it cannot rise to the because it is denser than the less salty water above. Hence a non convective solar pond is best utilized for storing the solar energy at a reasonable cost.

**Performance analysis:**

Extraction of thermal energy in the lower layers of the pond can be easily accomplished without disturbing the non-convicting salt gradient zone above. Hot water can be extracted from a solar pond without disturbing the concentration gradient. This is achieved by installing the water outlet at the same height as the water inlet. Hot brine can be withdrawn and cold brine returned in a laminar flow. Pattern because of presence of density gradient. For small or model ponds because of presence of density gradient ,heat exchangers consisting of pipes can be placed in hot lower layers ,but this entails not only the initial installation cost but the continued pumping loses associated with the heat transfer fluid.

 The solar pond is separated into three zones for thermodynamic analysis.

 The thermal(energy)efficiency :

*a*)upper convective zone (UCZ) can be expressed as

$$\eta = Q_{net} / Q_{in}$$

$$Q_{net} = Q_{in} - Q_{out} = (Q_{solar} + Q_{down}) - (Q_{wa} + Q_{side})$$

Where

Qnet = net heat stored in UCZ

Qsolar = net incident solar radiation absorbed by the UCZ

Qdown = total heat transmitted to the zone from the zone beneath it

Qside = heat loss to the side walls of the pond

Qwa = heat loss to the surroundings from the upper layer

$$\eta ucz = 1 - \frac{(Qwa + Qside)}{(Qsolar + Qdown)}$$

Qwa = UwaAucz(Tucz -Tamb)

Qside = (UsideAside(Tucz-Tside)

$$Qdown = \frac{K \quad Aucz \ (Tdown - Tucz)}{X1}$$

Where  K = thermal conductivity; X1 = thickness of the first layer

Qsolar =   ßAucz  h1

Where

 h1 = ratio of energy reaching layer 1 to solar radiation incident on the pond surface

A = area of the pond

ß= incident beam rate entering into the water.

*b*) The thermal (energy) efficiency  for non convective zone ( NCZ)

Qnet= Qin-Qout = (Qsolar + Qdown) -( Qwa+ Qside)

$$\eta NCZ = 1 - \frac{(Qwa + Qside)}{(Qsolar + Qdown)}$$

Qwa = UwaANCZ (TNCZ -Tamb)

Qside = (UsideAside(TNCZ-Tside)

$$Qdown = \frac{K \quad ANCZ \ (Tdown - Tncz)}{X1}$$

K = thermal conductivity; X1 = thickness of the first layer

Qsolar =   ßA NCZ h1

Where

$h_1$ = ratio of energy reaching layer 1 to solar radiation incident on the pond                         surface

A = area of the pond

ß = incident beam rate entering into the water.

*c)* The thermal (energy) efficiency for lower convective zone ( LCZ)

Qnet = Qin-Qout = (Qsolar + Qdown) -( Qwa+ Qside)

$$\eta LCZ = 1 - \frac{( Qwa+ Qside)}{(Qsolar + Qdown)}$$

Qwa = UwaALCZ (TLCZ -Tamb)

Qside = (UsideAside(TLCZ-Tside)

$$Qdown = \frac{K}{X1} ALCZ (Tdown - TLCZ)$$

K = thermal conductivity; X1 = thickness of the first layer

Qsolar =    ßA LCZh1

Where

h1 = ratio of energy reaching layer 1 to solar radiation incident on the pond
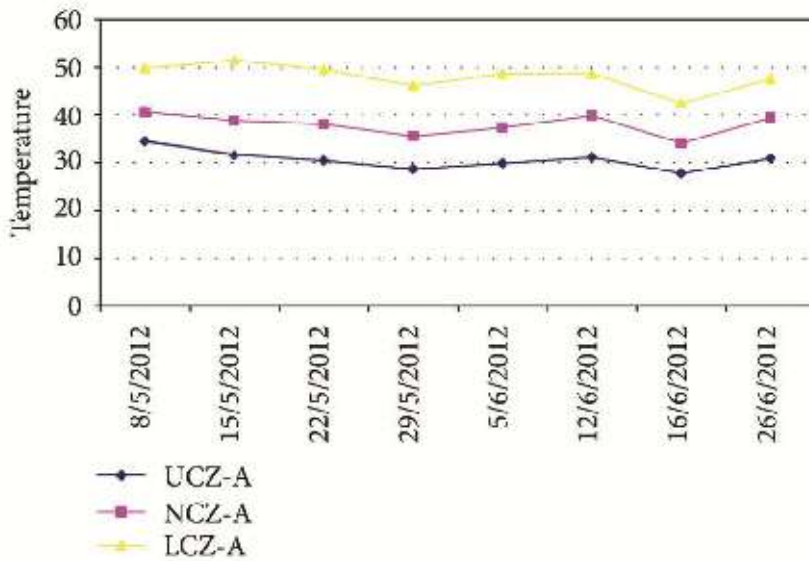
Figure : 3 graph between temperature and duration of time.
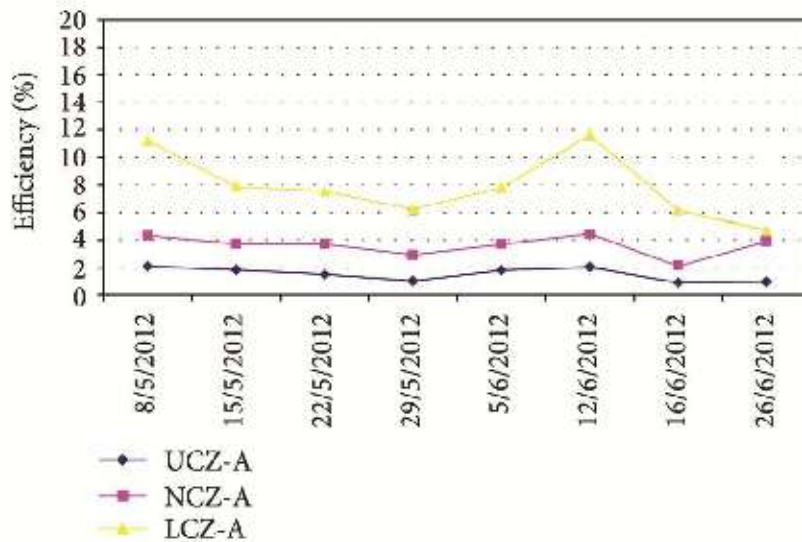


Figure 4; the efficiency graph of a solar pond

The experimental efficiencies values of NCZ are 59% and 44% respectively .Because of lower heat losses in this layer , it has a higher efficiency than UCZ layer

The experimental efficiency values of the LCZ are 52 and 26 respectively. Because most of the energy is stored in this zone, it has higher efficiency than the other two layers

## POND CONSTRUCTION

The site is selected for the construction of solar pond should have the following attributes:

(a ) be close to the point where thermal energy from the pond will be utilized;

(b) be close to a source of water for flushing the surface mixed layer of the pond;

(c)the thermal conductivity of the soil should not be to high;

(d)The water table should not be too close to the surface.

For constructing a non convective solar ponds an insulated and double-glazed covered salt gradient solar pond having a surface area 1.6 m × 1.6 m and a depth of 1 m has been fabricated. The LCZ IS 0.5 m high from the bottom of the pond with high-density brine. Approximately 0.1 m of fresh water on the top makes the UCZ containing light density brine , above which there is gradually decreasing density brine. This region performs the insulation , that is , keeps the stored energy in the bottom zone ,called NCZ. This zone has a height of 0.3 m . the total thickness of the side walls in which a glass wool is used for insulation is 8 c.m.The energy obtained from this system can be stored below the boiling point of brine . under the bottom of the pond a concrete with blocking with filling gravel of 0.12 thickness is fixed . The inner surface which is made by A$l$, is

blackened to absorb and store the maximum sun's energy . The bottom surface area is 1.2 m× 1.2m and expanded to an exposed surface area to collect the heat energy in a large amount .The side  walls of both the models were exposed at an angle of 110° from the bottom surface .The total thickness of top glazing is 1.4 cm with gap space of 1 cm.The source of water supplying in solar pond is a tank of 300-liter capacity placed at height of 5m from the bottom surface level of the pond. A galvanized iron pipe (DIA − 2M ,L=6M) is directly connected to the bottom of the pond. Below different types of salts ,and the extracted thermal and electrical power are given. Salts like sodium chloride ,magnesium chloride and sodium carbonate are considered and the power extracted from the theses sources are encompassed in the  below table. Also the amount  of flow rate maintained with different pond area are explicated

| Salt Type | Solar pond area (m²) | Flow rate Cm³/min. | Thermal power M.Wt | Electrical power MWe |
|---|---|---|---|---|
| Sodium chloride (NaCl) | 181115! | $13.6 \times 10^5$ | 400 | 10 |
|  | 149 | $11 \times 10^6$ | 320 | 8 |
|  | 906 | $6.9 \times 10^6$ | 200 | 5 |
| Magnesium chloride (MgCl$_2$) | 181115! | $41.3 \times 10^5$ | 400 | 10 |
|  | 149 | $33.1 \times 10^5$ | 320 | 8 |
|  | 906 | $20.6 \times 10^5$ | 200 | 5 |
| Sodiumb carbonate NaHCo$_3$ | 181115! | $21.6 \times 10^5$ | 400 | 10 |
|  | 149 | $17.2 \times 10^5$ | 320 | 8 |
|  | 906 | $10.7 \times 10^5$ | 200 | 5 |

An estimate of the area required for solar pond to minimize heat losses and liner costs ,the pond should be circular. since a circular pond is difficult to construct ,a square pond is normally preferred. In some cases such as the  Bangalore  solar pond ,the site constrains may force to construct a rectangular pond with large aspect ratio. For large solar ponds the shape will not have a strong influence on cost or heat losses. The depth of the solar pond must be determined depending on specific application. The usual difference of the surface gradient and storage zone of the pond are 0.5,1 and 1m respectively. If a particular site has low winds  , one can reduce the thickness of surface layer to 30 cm. If the temperature required for the process for the heat applications is around 40°c then the thickness of the gradient zone can be reduced to 0.5m.Storage zone thickness higher than 1m may be required to take care of long periods of   cloudiness.

## SALT REPLENISHMENT

On account of the gradient of concentration between the storage and the surface zones   , there is a diffusion of salt through the gradient zone. The transport of salt through the gradient zone by diffusion can be expressed as

$$Qm=[(Sr-Su)D]/b, \hspace{3cm} (1)$$

Where b=thickness of gradient zone   ,D=mass diffusion coefficient , and $S_t$ ,$S_U$=salinity in lower and upper mixed layers ,respectively.
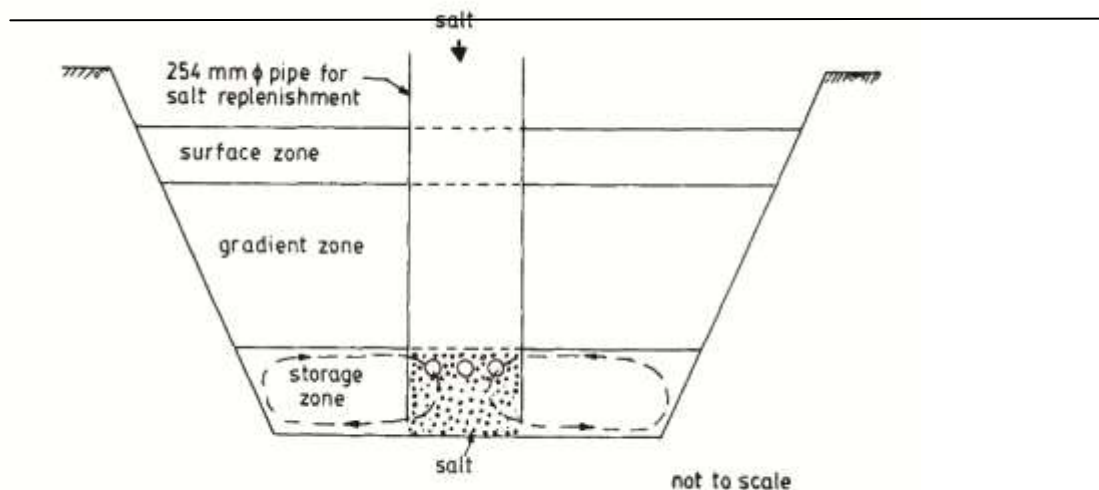


**Figure 11.**   Passive salt replenishment.

If the salinity in the storage zone is 300 kg/cubic metre and In the surface zone is 20kg/cubic m, gradient zone thickness is 1m and diffusion coefficient of salt is 3*10-9 sqm/sec. then the rate of transport of salt by diffusion will be about 30kg/sqm year .In small polar ponds the salt transport can be as high as60 kg/sqm year because of additional salt transport through side wall heating.

If the salt lost from the storage zone is not replenished regularly then there may be an erosion of gradient zone from below or formation of internal convective zones .The normal method of salt replenishment is by pumping the brine in the storage zone through

a salt bed; It was shown that for small solar ponds a passive salt replenishment technique is adequate .In the Banglore solar pond about 100 kg of salt is added daily through a chute into the storage zone. The salt that was added dissolved within a day.

## ALGAE CONTROL

The thermal efficiency of a solar pond is strongly dependent upon the clarity of the pond which is reduced by the presence of algae or dust. Bits of debris, dust or leaves lighter than water float on the surface and can be skimmed off. Dust and debris much lighter than water will sink to the bottom .The dust accumulated at the bottom of the pond does not adversely affect the absorption of solar radiation at the bottom of the pond. The dust floating in the gradient zone can be settled by adding alum. The growth of algae can be controlled by adding bleaching powder or copper sulphate .If the water used in the pond is alkaline, copper sulphate will not dissolve. Hull(1990)has proved detailed account of the relative merits of various methods of algae control.

## ECONOMICS

Solar energy conversion devices have not found widespread application because they require high initial capital investment. The cost of solar pond is much less than that of the conventional flat plate collectors. The cost of solar pond is however, strongly dependent upon site specific factors such as local cost of excavation and salt. The thermal performance of solar pond is also dependent on the site specific factors such as solar irradiation, ground thermal conductivity and water table depth. Hence there is bound to be large variation in the cost of thermal energy produced by solar ponds at different sites.

Considering detailed analysis of the various components of a cost of a solar pond. If the cost of salt and its recycling is excluded , estimated the cost of large solar pond(area>100,000sqm) to be around US $10/sq m(in 1986) and that of small solar pond (area around 100sqm) to be around US $50/sqm.If the cost of salt is $40/tonne the cost of large and small solar ponds are around $45/sqm and $85/sqm respectively. In the estimates, the cost of salt represents 50% of total cost of small solar ponds and more than 75% of total cost of large polar ponds be located close to sites where salt is available at low cost .In India small solar ponds can be constructed at a cost of Rs200 to Rs400/sqm. The following is breakdown of the cost of the solar pond per square metre
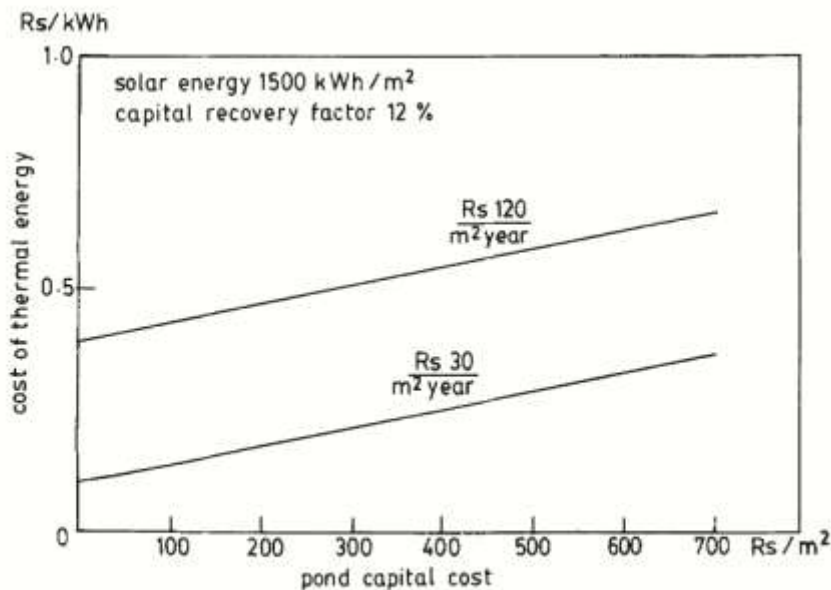


**Figure 12.** Cost of thermal energy as a function of pond capital cost.

$$C\dot{p}=2.546(C1+C2)+0.675C3+1.3C4+0.456C5+0.0415C6+0.124C_7+0.021C8+0.085C9+C10$$

$$(8.1)$$

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Where C1= excavation charges, Rs /cubic m ;C2=water charges, Rs/cubic m ;C3=salt cost Rs/tonne;C4=liner cost Rs /sqm;C5=clay,Rs/tonne;$C_6$=cost of bricks, Rs/1000 bricks; C7= cost of cement, Rs/bag ;C8=cost of sand ,Rs/cubic m ;C9=cost of brick lining, Rs/cubic m;C10=cost of wave suppresser, Rs/ sqm.

The net present value method to estimate the cost of thermal and electrical energy from solar ponds can be estimated as

$$Cth=[CRF*C\dot{p}+Cm]/np* Si \qquad (8.2)$$

Rs/sqm;Cm=maintainance cost of solar pond,Rs/sqm;np=Thermal efficiency of solar pond,Si=average incident solar energy ,k wh / sqm year.

The variation of the cost of thermal energy from the pond for various values of the capital cost of the pond and the maintenance cost of the pond is shown in above figure.We find that solar ponds produce thermal energy at a cost lower than that obtained from burning fossil fuels or electricity.     The estimated the cost of electricity obtained from a solar pond as follows:

$$Ce=[Cr\{Cp+Cpp*Ge/N\}+Cm]/(1-f)Ge \qquad (8.3)$$

Where Ce=cost of electricity,Rs/k  ;Cr=capital recovery factor;Cp=cost of solar pond,Rs/sqm; Cpp=        cost of Rankine    cycle power plant Rs/kwhe;Ge=gross electricity generation, kwhe/sqm;N=number of   hours of operation per      year;Cm=maintenance cost, Rs/sqm;f=fractional parasitic losses.

If we assume that Cr=0.125,CF=Rs 140/sqm, Ge=20 k-Whe/sqm,Cpp=Rs1500/K We          ,N=5000h,Cm=Rs7/sqm, and f=0.2,we obtain Ce=Rs2/k .Where we find that the cost of electricity        obtained          from the solar pond power plant is higher than that obtained from fossil fuel based thermal        power plants but is        comparable to the cost of electricity from diesel generation sets. From the above        analysis we can also infer that the cost        of the electricity from the solar pond power plant can be        reduced to Rs1/kwh, the capital cost of the solar pond          reduces to Rs12/sqm. This is impossible to   achieve unless there is a natural site(such as salt lake) which requires no salt    digging ,or liner .We   can   conclude   therefore   that electricity generation from the solar pond is not economically  viable    unless the site conditions are extremely favourable.

## THE EFFECT OF RAINFALL:

Rainfall can have beneficial or detrimental effects on the operation of a solar pond. If the rainfall is        not heavy, it     helps  to maintain the density of surface layer at low value. During the monsoon, in the     Bangalore solar pond, there        was  no  need  for flushing the surface layer to maintain the density at low        rate .Heavy monsoon rainfall can,  however ,penetrate to the gradient zone and dilute it. The analysis     of heavy rainfall episodes in Bangalore solar        pond indicates that raindrops can penetrate to about 50cm from the surface. Hence it may be desirable to maintain  higher surface zone thickness during        the rainy season.

## SOLAR POND APPLICATIONS:

**1.)Heating and Cooling of Buildings**: Because of the large heat storage capability in the lower    convection zone of the solar pond, it has ideal use for heating even at high latitude stations and for        several cloudy days.

**2. Production of Power**: A solar pond can be used to generate electricity by driving a thermo-electric    device   or   an   organic Rankine cycle engine - a turbine powered by evaporating an organic fluid with   great promise in those areas where there is sufficient insulation and terrain, and soil conditions allow        for construction and operation of large area solar ponds necessary to generate meanings quantities of electrical energy.

**3.Industrial Process Heat**: Industrial process heat is the thermal energy used directly in the        preparation and of treatment of materials and goods manufactured by industry. Several scientists        have determined the economics of solar pond for supply of process heat in industries. The heat from     solar pond is highly competitive with oils and natural gas.

**4. Desalination**: The low cost thermal energy can used to desalt or otherwise purify water for       drinking or irrigation. The multi-flash desalination plant below 100ºC which can well be achieved by     a solar pond. This system will be suitable at places where portable water is in short supply and          brackish water is available. It has been estimated that about 4700 m3/day distilled water can be obtained from a pond of 0.31km2 area with a multi-effort distillation unit.

**5. Heating animal housing and drying crops on farms**:Low grade heat can be used in many ways on farms, which have enough land for solar ponds.   Sever small        demonstration ponds in Ohio, Iowa and Illinois have been used to heat green houses      and hogbarns.

**6. Heat for biomass conversion**: Site built solar could provide heat to convert biomass to alcohol or        methane. While no solar ponds have been used for this purpose, it is an ideal coupling of two      renewable-energy technologies.

## CONCLUSIONS

Solar pond technology has made tremendous progress in the last fifteen years. An excellent monograph is now available on the science and technology of salinity gradient solar ponds (Hull et al 1989).This technology is cost effective for low temperature process heat needs of industry. The generation of electricity using solar ponds is not economically viable as yet .However , the new concerns regarding the environment and safety of nuclear power plants and nuclear wastes disposal may change the picture totally.

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# Comparative Study of Different Leaching Procedures

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**ABSTRACT -** Leaching is a natural process by which water soluble substances, (such as Ca, fertilizers, pesticides) are washed out from soil or wastes. These leached out chemicals, called leachate(s), cause pollution of surface and subsurface water. Experts in Municipal Solid Waste Management often require conceptualization of the leachability of metals in order to assess the risk of landfills to human health and environment. Literature identifies more than 100 leaching methods to remove soluble components from a solid matrix. In this study four potential leaching procedures used for municipal solid wastes are studied and compared to suggest the effects of these metals to the environment

**KEYWORDS -** Solid Waste Management, Leachate, Heavy metals, Laboratory tests, Water Pollution, Sanitary landfills, Comparative studies,

## INTRODUCTION

Disposal of Municipal Solid Waste (MSW) without source segregation in landfills is the usual practice in developing countries. In such practice usually other hazardous wastes, e.g. pesticides, e-wastes, batteries, paint residues, incineration residues, are indiscriminately also added which increases the heavy metal content in MSW dumpsite environment (Pare et al., 1999).

When large quantities of waste are being dumped, emanating pollutants contaminate the ground water and the soils, especially as a result of leachate of heavy metals such as zinc (Zn), cadmium (Cd), lead (Pb), copper (Cu), nickel (Ni), iron (Fe) and arsenic (As) in varying concentration. Thus it is important to know both the total content of hazardous substances and the chemical forms in which they are present in sludge.

The mobility and toxicity of heavy metals present in landfills depend on the chemical form of the metals. It has been reported that a major portion of the total metal content in MSW is inert form, unlikely to undergo chemical reactions in landfills but leach from the waste bed (Tessier et al., 1979). The toxic effects of solid wastes are known to be greatly influenced by their heavy metal contents (Esakku er al, 2006). Knowledge of heavy metal content, their species and the leachability at various environmental conditions from the dumpsite is a prerequisite for the assessment of reclamation and hazardous potential of the reclaimed waste, when it is used as compost for agricultural applications. Since the effect of heavy metals is influenced by their form of existence (Norvell, 1984) assessment of the species of metal ions enable to evaluate the sustainability of mined waste as compost or cover material.

Leaching tests are used to reveal the soluble phases of a sample help quantify toxic inputs due to mobilization of contaminants, helps to know what proportion of metals present in residue can be removed by leaching, to know the behavior of a dump of the material when exposed to external influences and how it will affect the environment.

Professionals in MSW management often require interpretation of the leachability of metals in order to assess the risk of landfills to human health and environment (Scott et al., 1990). Leaching tests are often applied in assessing worst case environmental scenario where components of the samples become soluble and mobile. Various leaching methods *viz.,* acid digestion, TCLP, ELT, SE, MEP etc., to remove soluble components from solid matrix have been cited in literature (Hesbach et al., 2001).

In this study four important tests, e.g. TCLP (Toxicity Characteristic Leaching Procedure), SPLP (Synthetic Precipitation Leaching Procedure), Column Leaching Test, EPTOX (Extraction Procedure Toxicity Test) are studied in detail because these tests have been widely used to generate leachate concentrations for all types of solids for a number of metals and organic chemicals. The pros and cons of these tests are discussed in he light of their usefulness in assessing the travel of metal ions through leachate in solid waste dump environment.

## LEACHING METHODS:

## TCLP (toxicity characteristic leaching procedure):

It is used to determine the mobility of organic and inorganic contaminants in liquid, solid and multi-phased wastes. It is also used to classify wastes (hazardous or nonhazardous) for purposes of disposal in a landfill.

It simulates the worst case scenario for disposal of waste in co-disposal landfill environment.

Particle size reduction is required, when the solid has a surface area per gram of material equal to or greater than 3.1 cm, or smaller than 1cm in its 2 narrowest dimensions.

Crushing cutting, grinding of the waste are done if the surface area is smaller or the particle size is larger than described above.

## SPLP(synthetic precipitation leaching procedure):

Chemical analyses of the filtered extract are conducted to determine the concentration of specified organic and inorganic constituents.

Used to determine the mobility of both organic and inorganic analytics present in liquids, soils, and wastes.

Is similar to TCLP except that the pH of the leachate is periodically adjusted up to specified maximum acid addition.

TCLP and SPLP are similar in test procedure. The primary difference between the two tests is the leaching media used. The acetic acid used in TCLP test is to simulate the major component found in leachate at any typical municipal waste landfill. The TCLP fluids are highly buffered and mildly acidic while the SPLP uses an un-buffered solution of sulfuric and nitric acids, at slightly more pH.

## EP-TOX(Extraction procedure toxicity test):

It is to determine whether a waste exhibits the characteristics of extraction procedure toxicity. Extraction takes place over a period of 24 hours with agitation. The liquid extract is analyzed for specific chemical constituents.

## Column test:

It is to determine the leachability of inorganic component from wastes as a function of the value of L/S ratio. The leachant is passed through a vertical column of the waste material in up-flow or down-flow manner, collected in fractions and analyzed.

## FACTORS CONTROLLING LEACHING UNDER FIELD CONDITIONS

Various physical, chemical, and biological factors influence leaching from waste and soil.

The physical factors are:

**Climate conditions:** The amount of net precipitation at a fill site will influence the amount of water available for infiltration through the site.

**Design of the fill site:** The depth of the fill will affect the quality of the leachate. The deeper the unit, the greater the contact time between the percolate and the fill material and thus there will be a greater opportunity for the leachate to reach saturation limits. Also, the deeper the unit, the longer it will take for contaminants to be depleted. Topography will affect the site's runoff pattern and the amount of water entering (via run-on) and leaving (via run-off) the site.

**Vegetation:** Vegetation limits infiltration by intercepting precipitation directly (thereby improving evaporation from the surface) and by taking up soil moisture and transpiring it back to the atmosphere (i.e., via evapotranspiration).

**Hydrogeological conditions:** Subsurface geologic conditions and depth to groundwater at a fill site can impact the generation of leachate. Materials below the water table provide a source of water provided precipitation and run on occurs.

The biological factors include the presence of microorganisms which on constant biodegradation can change redox potential and pH conditions affecting the solubility of contaminants.

In addition to the above for most in-organics the controlling factors for leaching are:

• **pH**

• **Redox conditions**

• **Solid to liquid ratio for extraction**

• **Solubility**

• **Solid phase compound**

And for most organic chemicals the controlling factors for leaching are:

• **Solubility**

• **Partitioning**

• **Presence of organic carbon**

• **Solid to liquid ratio for extraction**

• **Non-Aqueous phase liquid**

## COMPARISON OF DIFFERENT METHODS:

| TCLP | SPLP | EP-TOX | COLUMN TEST |
|---|---|---|---|
| evaluates metal mobility in sanitary landfills.<br><br>The purpose is to classify wastes (hazardous and non-hazardous).<br><br>uses 1:20 L/S ratio. | evaluates the potential for leaching metals into ground and surface waters.<br><br>The purpose is to determine the leaching potentials of soil, waste and wastewater.<br><br>-uses 1:20 L/S ratio. | determines whether a waste exhibits the characteristics of extraction procedure toxicity.<br><br>uses 1: 16 L/S ratio. | determines the release of constituents from material and with that the potential pollution of the environment with those constituents over a long period of time.<br><br>is a dynamic test to determine leaching from L/S ratio 0.1 to 10. |
| The TCLP extraction fluids were developed to stimulate a worst case scenario, when the waste is disposed with municipal solid waste. | The SPLP extraction fluid is intended to simulate precipitation. | The EP-TOX is used to simulate the leaching which a waste may undergo when disposed of in a sanitary landfill | is designed to simulate the flow of percolating groundwater through a porous bed of granular material. |
| The TCLP extraction fluid is buffered organic acid solution at pH 4.98 (the pH remains constant). | The SPLP extraction fluid is not buffered (the pH level fluctuates). | The extraction fluid is acetic acid solution at pH 5. | NA |
| Reagents- HCl, HNO3, NaOH, CH3CH2OOH | H2SO4, HNO3 | Reagents- CH3COOH, water | NA |
| The extraction time is 18 hours. | The extraction time is 18 hours. | The extraction time is 24 hours. | The extraction time depends on whether the test is meant to be a short, medium and long term. |
| Simulated weathering- 100 years in a landfill. | Simulated weathering- 100 years exposure to acid rain. | NA | NA |
| Static test. | Static test | Static test | Dynamic test |
| Inexpensive to perform | Inexpensive to perform | NA | Cost data are not available |
| Precision data are available | Precision data are available | NA | Relatively precise |

| | | | |
|---|---|---|---|
| | | | |
| Initial pH of the test may not reflect the actual field pH conditions | Initial pH of the test may not reflect the actual field pH conditions | NA | NA |
| Conducted under aerobic conditions | Conducted under aerobic conditions | NA | NA |
| Particle size reduction may be required | Particle size reduction may be required | NA | The size of the particles used in the test is controlled |

## ACKNOWLEDGMENT

## CONCLUSION

Background knowledge of the sources, chemistry, and potential risks of toxic heavy metals in contaminated sludge is necessary for the selection of appropriate remedial option. In order to minimize the health risks and environmental pollution, it is important to know both the total content of the hazardous substances and the chemical forms in which they are present in sludge. Leaching of heavy metals from the sewage sludge is of great importance to ensure safe disposal of sludge. The negative impact of sewage on the environment should be reduced by leaching procedures. At each leaching process, sewage should be purified to such an extent so that it would not detrimentally affect the environment. Therefore, constantly analyzing and checking the effectiveness of sewage leaching, in accordance with standards and regulations in force, provides an important criterion for the assessment of sewage treatment. The selection of the leaching methods is not a simple task. It varies according to the sample size, particle size distribution, the leachant volumes and pH and the duration of the leaching test. A careful investigation of these parameters is needed prior to finalization of the test procedure.

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# EROS AS A CONSTANT IN NIKOLIC'S POETICS

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**Abstract-** The depth of the problems that Nikolic procedures in his movies arise from the specific subject matter that was unlike some other arts, above all literature, in this field of aesthetic expression in the unique cultural and conceptual framework of former Yugoslavia, less prevalent. Although it is difficult to talk about their polyphonic or polymorphic characteristics, the clear and dramatic functional narratological structure of his movie stories should be pointed out, so much more since Nikolic never dealt with esoteric subjects and vain speculations, but he tried to rise the narrative statement to a level of absolute recognition, especially when he the anthropological discourse embodied in traditional norms, mystical and theological dogmas were involved. In such an approach, abstracting straight guided plot lines and extensive exposures, we can undoubtedly speak of full compliance and *permeation* of all the expressive constituents of the diegetic structure in Nikolic's movies. A strongly emphasised demystification of ultra-traditional interpretation of eros and  simultaneously its relationship with ethos, the constant confrontation with extreme ethical views and distorted visions, as well as his persistence in debunking the dominant and burdensome taboos, are particularly important in Nikolic's narrative. Thus *comprehended* Eros together with so-called "forbidden topics" and their hidden and often ambivalent meanings, including possible deviations from their essence, often take precedence over other thematic elements in the dramaturgical structure of Nikolic's movies.

**Key words:** Eros, Tanathos, Libido Sexualis, tradition, idiosyncrasy, transcendency, homosexuality.

## 1.Introduction

Montenegrin director Zivko Nikolic was a unique personality of former Yugoslav cinematography. With his distinctive geo aesthetic approach filled with numerous paradoxes, although not directly related to the paradox of his contingent pseudocentricity, which a low level criticism often stressed as an argument against him, and as well a rare gift for observing details, Nikolic manages both cinematically convincing and vivid to pass onto the screen the customs of the people in the area he originates from and at the same time to transform them into strong poetic metaphors. It is possible to talk about Nikolic's poetics as a specific and, in many ways, unique aesthetic synthesis, in which intertextual intertwining makes one of its essential qualities. Nikolic never dealt with superficial factography. As a matter of fact, he kept trying to raise the issue he interpreted to the level of an aesthetic fact, i.e. that from the manner in which it appears its universality breaks out. Nikolic's movies are mostly different from the ones of the Yugoslav authors known as "The Belgrade Circle" and "The Czech School". In fact, more than a decade Nikolic was a true counterbalance to all dominant styles and currents in Yugoslav cinematography. He also did not belong to any film school, style or movement, as if he did not belong to the chronotope  in which he created, but the one he himself created in his movies.[1]

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[1] Nikolic was born in Ozrinici, a village near Niksic, Montenegro, in 1941, where he died and was buried in 2001.  Although he won a few national awards for his outstanding artistic achievements  and more than a hundred prominent international awards for his movies, Nikolic died in poverty, frustrated, forgotten, and almost starving, like a beggar. When in former Yugoslavia in the early nineties broke the savagely brutal Civil War and bloodthirsty nationalists took their positions, the themes Nikolic offered to producers were not acceptable.  Nikolic is the author of seven feature movies, twelve documentaries and two television series. His feature movies, which we analyze in this paper, were made from 1977 to 1989: THE BEASTS, 35mm, color, 2700m. Production Co: Avala film, Belgrade / Zeta film, Budva / Dunav film, Belgrade / Filmski studio, Titograd. Country: Yugoslavia. Year of release: 1977; JOVANA, LUKE'S WIFE, 35mm, color, 2700m. Production Co: Avala film, Belgrade. Country: Yugoslavia. Year of release: 1979; THE DEATH OF MR.GOLUZA, 35mm, color, 2423m. Production Co: Avala film, Belgrade / Avala pro film, Belgrade /Slovenska filmowa tvorba Koliba, Bratislava / Kemal i partner, Salcburg. Country: Yugoslavia. Year of release: 1982; THE UNSEEN MIRACLE, 35mm, color, 2516m. Production Co: Zeta film, Budva / Centar film, Belgrade. Country: Yugoslavia. Year of release: 1984; THE BEAUTY OF VICE, 35mm, color, 3050m. Production Co: Centar film, Belgrade. Country: Yugoslavia.
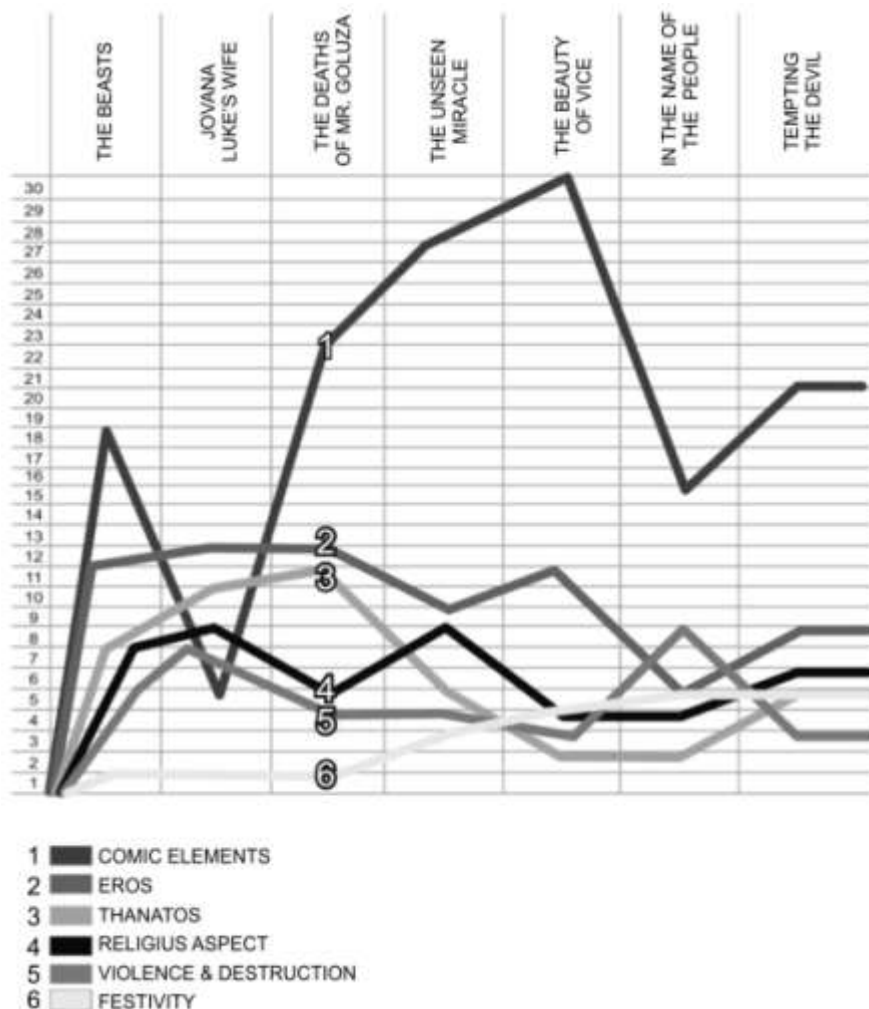
Figure 1: The basic structural constituents in Nikolic's diegetic discourse

The upper graph which includes the key segments of the diegetic structure of Nikolic's feature movies is the result of exact duration measure of each individual frame. By their simple summing up in relation to the proportional graphical values, we have come to the result shown in this table, which unambiguously and clearly points to the fact that the elements of erotic narrative compared to others in all Nikolic's movies are constant, and, for the most part, evenly represented, excluding the movie *In the Name of the People*, in which the focus is on the political violence of the communist oligarchy which, consequently, includes the sexual one.

## 2.Eros

## 2.1. *The conceptual definition of Eros and Thanatos*

In defining the notion of Eros we bear in mind the one from the ancient mythology of Eros as a symbol of love, or a motion that leads to the convergence of beings, and as well Sigmund Freud's interpretation of Eros as the preservation of the species. (*Freud*, 2010.) We have also taken the term Thanatos from the ancient mythology, in which it refers to death and is, in fact, its incarnation. [2] But, our *main* intention is to point out the comic and tragicomic aspects of Eros, as one of the most dominant features in Nikolic's poetics, taking into account the other thematic frameworks closely related to this issue. As an example in this sense we could extract the sequence from Nikolic's movie *The Beasts* in which old dying captain entreats the young, mysterious girl, who had come quite unexpectedly to the island, to reveal her naked body. In fact, Nikolić rises Eros to a much higher level than traditionally acceptable one, usually given in distant hints through motion or allusion, and at the same time resolutely and transparently copes with false darkness, symbolically represented by the blindfold, in the movies*: Jovana, Luke's Wife, The Beauty of Vice, Tempting the Devil*, opening the door of his diegetic universe to the emanation of released erotic energy. At this point, we want to indicate the endeavor of an artist who in a comprehensive and aesthetically compelling way underline the misconceptions that persist under the veil of ignorance. He actually wants to reveal the "secret" of *homo eroticus* under external circumstances where each action is exposed to the court of public opinion. That's why we pay so much attention to this aspect, which is together with thanatos and the structural elements of comic discourse, the key thematic constituent of Nikolic's entire *oeuvre*.

## 2.2. *The erotic models*

Is it also possible to say that in Nikolic's movies eroticism, as this issue on the film sees the French film theorist André Bazin, appears as the basic purpose and content? (*Bazin*, 1976.) We are apt to say *as the basic purpose*: no! The second part of Bazin's thesis, however, entirely corresponds with Nikolic's use of erotic models, where this segment, if not the unique and essential, is at least in many aspects specific. Nikolic neither experience eroticism as a kind of unmotivated, instinctive, raw passion imbued with amoral actions, one that has its own purpose and goal, nor only as a demystification of the beauty of female/s body and sexual act. Erotica, as Nikolic used to say, is no cheap clothes. Erotic being is eternal and pervasive. Eros is life itself! And why, then, it could not be transferred onto the screen in its genuine form? And finally, why it should be a bigger disgrace than killing, torture, abuse, suffering, humiliation, rapes that can be seen in most contemporary movies that official institutions, although do not openly support, yet approve. Nikolic, therefore, did not make war movies, not even those with partisan issues. The only war that he led was the war of emotions and passions. Anything outside that scope he left to the professional pyrotechnics and firework experts. The sequence from the movie *The Unseen Miracle* in which the owner of the rural pub, called Baro, throws gold coins at the navel of young American girl while she was dancing, undoubtedly confirms the this thesis. Nikolic never aspired to the obscene eroticism, sexual depravity and morbidity unless it was diegetically unavoidable. However, destructive sexual scenes, as well as those arising from raw instincts and low passions, in Nikolic's movies are evident, but not to the level that they could jeopardize the initial structure of the story and substantially modify its original idea. These extremely cruel and disturbing sequences, particularly in the movie *Jovana, Luke's Wife*, in that sense could be compared to those from Ingmar Bergman's *Jungfrukällan* (*The Virgin Spring*) from 1960. The specific national idiosyncrasies of this part of Europe can be seen as a branch of a much broader geoaesthetic space and, in the context we are talking about, bring into close relation with the prototypes of Mediterranean provenance, primarily Casanova and Don Juan. None of these eternal lovers, however, is not a real prototype in any of Nikolic's movies. [3]

## 2.3. *Critique and Eros*

Nikolic's movies had often been targeted almost equally by movie critics and the official institutions. In this regard the response of the Serbian Orthodox Church to the trailer of Nikolic's movie *The Unseen Miracle*, broadcasted by Belgrade television, will remain as one of the most curious. This problematic trailer, as prelates claimed, insulted their priesthood in an untrue, immoral and cruel

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[2] Eros (Ancient Greek: Ἔρως, "desire"), in Greek mythology was the god of love. Some myths make him a primordial god, while in others he is the son of Aphrodite. Thanatos (Ancient Greek: Θάνατος, "death"), in Greek mythology was the god of death.

[3] Perhaps the closest to that definition is Goluza, whom some unusual and unbelievable circumstances had made their surrogate. In a way this could be said for the "martyr" Andjelko from *The Beasts*, con artist Georges from *The Beauty of Vice*, but also for Father Macarius from *The Unseen Miracle,* who his art of lovemaking brings in a close liaison with the pseudo-dogmatic and religious beliefs. But, on the other hand, as in the case of *The Beauty of Vice* and *The Unseen Miracle*, if his heroes are not Casanovas or Don Juans, they are either funny voyeurs or frustrated commentators.

manner. A few sequences in which the parish priest appears in the role of local Casanova, provoked a strong reaction and condemnation and caused plenty of controversy, so that the church declared this movie heretical, the attitude that caused its removal from the Belgrade television program schedule, although it had been earlier repeatedly broadcasted. The attack on this movie is the testimony of the social and political situation in the ex-Yugoslav region in the early nineties. Nikolic's movie *The Unseen Miracle* was made in 1984, and remained in cinema network until the communists were in power. No one had been bothered by this anathematized, "scandalous" scenes at that time, especially not the communists. However, when the position of the official communist ideology, which often included harsh repression, had begun to wane, such a reaction inevitably followed. All this, on the other hand, suggests that the art and culture had never been entirely independent in former Yugoslavia. They were fully controlled by different institutions and there was always a danger hanging over them like the sword of Damocles.

3.The Freudian theoretical assumptions

In almost all Nikolic's feature movies, if not explicitly, then in key segments as a hint, Freud's theoretical assumptions of eros and thanatos are present. It is obvious that these psychological conceptualizations were not unknown to Nikolic, although, unlike some other Yugoslav directors, for example Dusan Makavejev, he did not meticulously deal with Freud's psychoanalytic postulates. In the erotic expression Nikolic primarily sees both the beauty and life extension, but also its end as presented in Freud's scientific doctrine. Eros and thanatos as two antithetical poles, passion and sexual gratification on one, and death on the other hand, were raised to the level of a global metaphor and make only one, albeit important part of the overall diegetic expression of Nikolic's movie stories stories. Furthermore, we must as well bear in mind that important fact that Freud marked *libido sexualis* as psychic energy much larger than the sex drive, and accordingly Eros is not one-dimensional entity, as it is usually misinterpreted, but the urge of life itself in contrast to the antipodal thanatos that is the death instinct. A typical example of this Freud's thesis can be found in Nikolic's movie *The Beasts* in the guise of old captain, who is difficult to determine whether he is more a victim of eros or thanatos. Neverthelles, Nikolic's characters have no particular relationship to death. More specifically this relationship in Nikolic's movie have all the elements of a grotesque with the unconcealed ironic overtones, iconographic and symbolic attributes that are constant, but also with *mise-en-scène* emphases in order to indicate its irrelevance (the irrelevance of death!) and its inevitable defeat in confrontation with eternally young and rebellious eros. As an obvious example in this regard we could single out the sequence of a grotesque "game" of eros and thanatos with the tragic epilogue in *The Beasts*, and a comical verbal communication in *The Unseen Miracle* between the main character Zeljo and a lascivious woman named Grana at the funeral of his grandfather.

3.1.*Libido Sexualis*

Starting from Freud's anticipation of the erotic nature of subconscious, the russian philosopher Boris Viseslavcev argues that eros involves much more than *libido sexualis*, even more than the erotic infatuation.[4] We venture to say that almost every Nikolic's movie absolutely confirms this Višeslavcev's thesis. Eros as the sublimation of life, or "love of life", its all-pervading energy and driving force, as well as avoiding its reduction only to the sexual intercourse, seems to make the basic guideline of Nikolic's understanding of its essence. Although in Nikolic's movies sexual urges are strongly underlined, it is not possible to talk about some fully refined emotions of a pure erotic love, which would be dominantly present. Moreover, it happens that such emotions, for some obscure reason, are sometimes distorted and made ridiculous. In fact, human evil tends to relativise them. Any free attitude towards them, in one way or another is sanctioned /the example of Andjelko and the beasts, Caruso and the American girl, Jaglika and nudists/. Nikolic also relentlessly breaks down this prejudice referring to man's erotic being, and, at the same time, removes the anathema from the free and unfettered love. He actually doesn't want to hide the love from life, and *vice versa*. Love and life are the two poles of an indivisible being. Their causal relationship and mutual interlacing are viewed as an ontological fact, material evidence of man's existence. Andjelko, the hero of *The Beasts*, tries to convince his friends, the beasts, that together with the *licentious E*ros, true love is possible. The response of the beast to this ontological fact in the final sequences of this movie is savagely cruel. Is Nikolic's faith in love faced toward the transcendental? It is the question that he leaves open, or for some reason refuses to respond directly.

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[4] Boris Višeslavcev, *The Ethics of Transformed Eros*. Logos. Belgrade, 1996, p. 40.

4.Eros and transcendence

Is Nikolic's faith in love faced towards the transcendental? It is the question that he leaves open, or for some reason refuses to respond directly. Although Nikolic implicitly hinted the unboundedness and infiniteness of transcendence in his movies, he primarily interpreted the world, which is, according to Hungarian writer, philosopher, and social critic Béla Hamvas, "an open and unified whole; cosmos in *aletheia*[5] - an unabashed universe.[6] This orientation towards the transcendental and the longing for the invisible, "the metaphysical desire", as the French philosopher Emmanuel Levinas determined it, which "strives for *something completely different*, *the absolute otherness*",[7] [italics added] even though it is in the core of Nikolic's poetics, does not make its essential constituent. This attitude, in other words, epitomizes the pursuit of invisible focused on the detection of otherness, one that "does not indicate the lack of relationship",[8] the understanding of the immaterial world only as a hypothetical, but not at all one that means the absolute detachment in relation to the sensory impressions. In this context, Nikolic perceives eros primarily as a phenomenon of immanence, for love, let's cite Levinas again "is not the way in which the metaphysical case of transcendence occurs."[9] Or, more exactly, Nikolic sees love as an absolute immanence, which, on the other hand, does not free eros the need for transcendental "touch", the desire for unsaid, which, according to Levinas, confirms not only the originality of eros, but also its duality.[10] This second, let's tentatively call it *the dual face of eros*, in case of Nikolic's approach to this problem, unlike Levinas' theoretical reflections, is neither the essential ambiguity nor duality. It is more the lust for discovering *unknown*, which is, according to Nikolic, sometimes unjustifiably marked as *secret*.

5.Eros and thanatos

Love in Nikolic's movies, as we have already seen, appears as an absolute immanence, and its numerous paradoxes as inevitable epiphenomena /*The Death of Mr. Goluza*, *The Unseen Miracle*, *Tempting the Devil*/. Searching for love fulfillment, according to Nikolic, can not be hindered, and in this process he recognizes not only the driving force of life, but also its entire meaning. Yet, love, as well as death, is rarely wise and prudent. This fact for Nikolic's heroes often means mental disorder /Bulut, Jovana, Goluza, to some extent also Zeljo/, even when thanatos inexorably approaches, as in the case of the dying Captain from *The Beasts*. The presence of thanatos is evident in almost all Nikolic's movies. There is no great passion in them, consequently the passion of erotic love, that is not targeted by thanatos. Its biggest enemy reason, however, has no influence over it. Nikolic also observes thanatos within the other, completely opposite, festive context, with obvious presence of irony and grotesque: "Concerning death our life gains some relevance, but loses as much and becomes devalued. It is interesting to see that theatrical funeral solemnity, repentance, ceremony in which everything gets a grotesque form. Death is always a celebration in Montenegro, an expression of love, strange, cruel and beautiful."[11] And that is one of the dominant motifs of Nikolic's "metaphysics of consternation". Death, therefore, is not so much associated with the fear of the deceased faced with the unknown as far as his fulfilled or unfulfilled deontological orders and, consequently, the eschatological uncertainty. Between light and darkness, Nikolic inevitably chooses light. To the destructive power of death he confronts love and life. Plunging into the eschatological secrets he leaves to the preachers. Hence the so emphasized suggestive power of eros, which is supposed to annihilate all that stands in the way of its eternal incarnation. Hence furthermore the so insatiable Nikolic's thirst for the naked female body, i.e. eros which is the only fundamental negation of thanatos. Pointing to the meaning and significance of eros in his movies, Nikolic also says: "It is probably a unique moment when a man really overcomes death."[12] And

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[5] *Aletheia* (ἀλήθεια) is a Greek word variously translated as *unclosedness*, *unconcealedness*, *disclosure* or *truth*. The literal meaning of the word ἀλήθεια is *the state of not being hidden; the state of being evident*.

[6] Béla Hamvas, *Magyar Hüperion* (*Hungarian Hyperion*). Matica srpska, Novi Sad, 1992, p.184. According to Hamvas something similar can be said of a work of art, which also coincides with Nikolic's reflections on the relationship between life and art: "The artwork is to the man as the world itself, open to all opinions, even indifferent to all of them. " /ibid., p.184./

[7] Emmanuel Levinas, *Totality and Infinity: An Essay on Exteriority*. Duquesne Univ Pr, 1969. [Levinas, Emmanuel Levinas: *Totality and Infinity: An Essay on Exteriority*. Veselin Maslesa, Sarajevo, 1976, p.17.]
[8] Ibid., p.18.
[9] Ibid., p, 238.
[10] Ibid., p. 239.
[11] Intervju, 16.08.1985.
[12] Sineast 57, 1982/1983

more: " In my movies erotica is sometimes a part of love, sometimes the impossibility of love, sometimes love itself. In any case, we know, this world would vanish without eros."[13] But eros in Nikolic's movies is never alone. It is accompanied by its eternal retainer thanatos, as in the case of the movies: *The Beasts*, *Jovana, Luke's Wife*, *The Death of Mr. Goluza*, *The Unseen Miracle* and *The Beauty of Vice*.

6.Eros, religion and homosexuality

Boris Viseslavcev goes so far as to define the overall creativity, culture and religion as a sublimation conducted towards revelation as the highest value, because "where is your highest value, there is also your Eros."[14] From the above we can conclude that eros itself is a true *nexus causalis* that leads to the revelation, which in Nikolic's movies is recognized as one of the key predilections. The connection between eroticism and religion is symbolically indicated in all Nikolic's feature movies, but never by their predominant presence nor open banality that would disregard their aesthetic dignity. The erotic symbol represented in such a way, on the other hand, can be brought to a close relationship with the archetype, i.e. its deeper layer, the collective unconscious, as it is defined by Carl Gustav Jung. (*Jung*, 1981.) Contact with the archetype is also apparent in this aspect of Nikolic's poetics and completely permeates the religious feelings of his characters. In this case, however, it is the phenomenon which is not inherent to objects in sensual reality, but the one which implies the transcendental relationship. Nikolic doesn't only revive myth and archetype in his movies, but in the most consistent interpretation of the collective unconscious "translates" them into the language understandable to contemporary audience. Perhaps one of the deficiencies of Nikolic's poetics can be found just in his attempt to simplify these motifs in order to achieve their absolute believability, or an effect that will be infused with not consistently fully motivated anecdotal humor.

6.1.*The ethical code*

The Montenegrin psychoanalyst Todor Bakovic supports one in a series of interesting, but also dubious theses of religious discrimination of women, whose eros is always younger and stronger, unlike man who is closer to thanatos. "Eternally young, alert, creative and productive Eros is really powerful. It escapes from one so authoritative power – God itself. ... Religion disposed of Thanatos easier, no matter how mature, vicious and destructive it is. It offered the afterlife." [15] Considering Nikolic's movies, and not only his when we are talking about idiosyncrasy, customary norms and moral norms in Montenegro, Bakovic's interpretation of eros and thanatos, pulled through the prism of a thoroughly dominant patriarchal ethical code, is a strong impression which strongly imposes. (*Bakovic*, 1985.) The eros of Nikolic's heroines is not only younger and stronger, but as well more enigmatic than the eros of his heroes. As an example we can take Jovana, Luke's wife, i.e. the transformation of her repressed sensuality from a genuine love to inconceivable and unmotivated murder of her husband, committed as a result of absolute unmasking the repressed libidinal *energy* that she could neither restrain nor resist to.[16]

6.2.*The Montenegrin customary law*

The powerful weapon of Christian theology with the aim of suppressing eros and imposing the feelings of sin, in Nikolic's movies gets a special importance. If for the sin committed by a woman, primarily the infidelity or murder of husband, as in the above case, we say that it is unforgivable, bearing in mind the provisions of Article 72 of Danilo's Code, derived from the Montenegrin customary law, the plot of this Nikolic's movie that has no explicit spacetime and even not iconographic coordinates, could be located in this chronotope.[17] But Nikolic does not apply this harsh sanction from Danilo's Code. Instead, since everything in this movie is *thrust* towards the *absurd*, Nikolic, following changes that are reflected on the face of his heroine, "pulls" the clatter of horses' hooves from the *acousmatic* zone, whose sharp sound, accompanied with the apparent fear due to committed sin, in her body, paradoxically inflames the "unpredictable" and "eternally young" eros. It is clear that the invisible horsemen remain a distinct threat, but not the one

[13] Ekspres, 26.08.1990.
[14] Boris Višeslavcev, *The Ethics of Transformed Eros*. Logos. Beograd, 1996, p.41.
[15] Todor Baković, *The Depressive optimism of Christianity*. Nikšić,1991, p.97.
[16] The ethnologist Vukasin Pesic in his meticulous research on the patriarchal morality of Montenegrins has come to very similar results.
[17] In 1855. on the initiative of the Montenegrin sovereign Prince Danilo I, the Code was enacted with the provision of Article 72 for serious crimes. This Code, inter alia, predicted harsh punishments for infidelit, including the so-called *osakata*, i.e. tearing off nose.

for the committed sin, because Nikolic is not concerned with it in the final sequence. Hence the emphasized antithesis of theological given in the form of anathema as a response to the committed sin in this Nikolic's movie, whose agent in this case is strong, unpredictable and destructive eros, i.e. the unbridled emanation of passions and sexual energy of the heroine. The victim in this movie story was chosen by eros.

### 6.3. *Homosexuality*

Nikolic was the first Yugoslav director who openly, without fear and contingent shame, in his movie *The Beauty of Vice* broached the topic of homosexuality. One of his heroes Gonce is an incarnation of homosexuality and the first character in former Yugoslav cinematography who was recognized as a gay whose role was not an incidental and ancillary one. We must also bear in mind the fact that customary and traditional laws, written and unwritten ethical rules as weel as socio-political circumstances were not benevolent in a country that was about to collapse and didn't provide enough opportunities to such a research. Nevertheless, Nikolic has launched many forbidden topics in his movies, including this one.

## 7.The poetic initiation of eros

### 7.1.*The beauty of woman*

The strength and power of woman's beauty in Nikolic's movies inevitably initiates the strength and power of destruction and desolation. "Maybe there is a certain truth in the assertion of some critics that I was purposely looking for nice, gentle and refined women that would more clearly emphasize the contrast with the harsh, yet beautiful in its own way, Montenegrin environment in which I was shooting." [18] No one in the former Yugoslav cinematography, as noted by movie critics both contemporary and noncontemporary, had been so much devoted to the beauty of woman and pointed out her tragic fate and the right to rebel.[19] Although Nikolic regards the beauty as "the most powerful" and "strongest", in *The Beasts* it brings evil, in *The Death of Mr. Goluza* is trying to confront evil, while in *Jovana, Luke's Wife* evil destroys it. These, according to Nikolic, are three completely different relationships. With beauty, hence the female beauty, Nikolic deals as a provocation of life, and searches for "the demonic it carries within itself."[20] The nudity of female body in Nikolic's movies is not only a symbol of erotic sensuality, but also the universal beauty, as it had been experienced by the great painters, his ideals, particularly Titian. One-dimensional deflection of the erotic discourse and its reduction solely on physical affection would be, according to Nikolic, simultaneous destruction of values that the story on the beauty of naked female body involves /we should only recall Zeljo's and Djoko's erotic fantasies from *The Unseen Miracle*/.

### 7.2.*The sublimation of erotic energy*

The narrative graduality in uncovering the female beauty, the sensuality and erotic passions that are making their way through one of the story layers, was as important to Nikolic as the very act of the erotic fulfillment. Even in movies with Thanatos as a dominant core around which other events dispersively spread, Nikolic retains the hints of erotic expression – an unobtrusive but powerful diegetic juxtaposition of lament and passion, which regardless of circumstances indicates the unpredictability and the power of eros. However, unlike his feature movies in Nikolic's documentaris there is no obvious presence of erotic elements. In these movies eros is mostly present in metaphorical indications, the reason why its diegetic recognition is completely turned in that direction. The phenomenological aspect of eros came into the focus of Nikolic's concern more comprehensively starting from *The Beasts*, his first feature movie. The predominant presence of erotic motifs and symbols, the aesthetic sublimation which implies the exemption from "the forbidden topics" and simultaneously points to the necessity of presence of the emotional gamus of relations, on one hand, but not the banal erotica devoid of the aesthetic distinctiveness, a meaningless divinization of sexual fetishes, the reduction of an erotic act solely on the bodily pleasure, on the other hand, are the basis on which Nikolic develops ideas related to this aspect of his poetics.The

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[18] Vijesti, 28.08.2001.

[19] Therefore, it is no wonder that the well-meaning critique called him "Montenegrin Bergman", though Nikolic "loudly" resisted any labeling, even though it put him in touch with the greatest movie directors.

[20] Danas, 04.07.1986.

mere desire for eroticizing and immoderate digressions are not Nikolic's *causa essentialis*, but they are, in most cases, the catalysts of dramatic events.

## 8.Conclusion

In Nikolic's movies eros is never reduced only to *libido sexualis*. It is always in the function of initial idea, one of many functional ingredients of their complex diegetic and narrative structure. The polarity of eros and thanatos, i.e. the permeation of two exclusionary relations, Nikolic rises to the level of a conceptual metaphor, not at all simplistic and incomplete, as it was in the Yugoslav movie criticism ocasionally presented. Eroticism is much more to Nikolic than it is the one-sided, limited and conservative pseudo-traditional comprehension of its essence, and often open fear of what will happen if the screen uncoveres the naked female body and shows its natural beauty, and together with the complete expressive scale of visual and sound effects enhance its plasticity and fullness? O*r more precisely,* it is one's concrete body, someone who is on the cinema screen a virtual being. And is it, finally, a presentation of something that should be hidden for some irrational, never fully perceived and clear reasons – the intuitive preservation of the secrecy of physical beauty, especially female, due to some inconceivable moral beliefs and vague fears governing the "controlled area" of human psyche and its untouchable and inviolable prejudice? Erotica is both beauty and life, the natural and essential emotional inherence, and in such a form, unchanged and purified, should be transferred on the screen. Luke, the hero of *The Beauty of Vice* puts a black binding across Jaglika's eyes. Although she is his wife, their sexual pleasure, however, is reduced to almost instinctive need with no magic that a free and unfettered erotic act can provide. But the story of an unexpected and complete Jaglika's erotic emancipation begins just here, in a montenegrin nudist camp. The very demystification of that "secret", eros as a fundamental ontological fact, together with contingent metaphysical implications, is evident in almost all Nikolic's feature movies. This is the crucial reason we attach in our analytical proceedings a special importance to this segment of research as one of the key aspects of Nikolic's overall poetics.

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# Artificial Intelligence based Battery Power Management for Solar PV And Wind Hybrid Power System

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**Abstract—** This paper proposes an approach for the hybrid solar photovoltaic and wind power system in Battery management for stand-alone applications with Artificial Intelligence. In general, Solar and wind energy are utilized as leading sources of energy and battery unit is considered as storage element to meet out the load demand. Loads are considered based on the priority. Ratings of hybrid energy system components such as solar PV, wind generator, battery unit, power electronic converter, etc., are optimally selected based on the rating of load. Fuzzy logic and Neural network are the tools being used here to obtain the maximum utilization of battery. A simulation model with MATLAB/Simulink for the hybrid power system has been developed. Considering power supply variation in Solar and Wind Hybrid Power system (SWHP) caused due to disturbed power supply from wind turbine generator and solar cells, fuzzy-PID-NN control is brought into it. The main components model of SWHP is established and simulation of fuzzy-PID-NN control is being presented, analyzed and compared. The final result of simulation indicates an effective utilization of battery.

**Keywords-** fuzzy logic; neural network; solar photovoltaic; wind power; battery management

## INTRODUCTION

Many Countries count on coal, oil and natural gas to supply most of their energy needs due to tremendous increase in population growth rate. But reliance on fossil fuels presents a big problem. Fossil fuels are a finite resource. Eventually, the world will run out of fossil fuels, or it will become too expensive to retrieve those that remain. Fossil fuels also cause air, water and soil pollution, and produce greenhouse gases that contribute to global warming. Renewable energy resources, such as wind, solar and hydropower, offer clean alternatives to fossil fuels. They produce little or no pollution and they will never run out. SWHP has a bright application to face electric demand in the near future. It can raise power supply reliability and reduce the system cost according to local environment condition and load characteristics of residents [1].

For stand-alone SWHP, lead-acid batteries play a vital role as an energy storage unit. Even though batteries are the weaker section in the overall system, they are in need of certain initial investment of equipment. As the management of charging/discharging in storage battery directly affects the quality of power supply in SWHP since electric energy from wind turbine generator and solar cells has obvious fluctuation. It makes the system great demand to electric power management. Therefore, it is significant to study power management of batteries in detail [2].

Conventional control theories do not have good performance for them. In this paper, the combination of fuzzy control and traditional PID control is presented along with Neural Network to solve the problem of battery management in Solar and Wind Hybrid Power system. And simulation result of the fuzzy and NN control system is compared at the end [3].
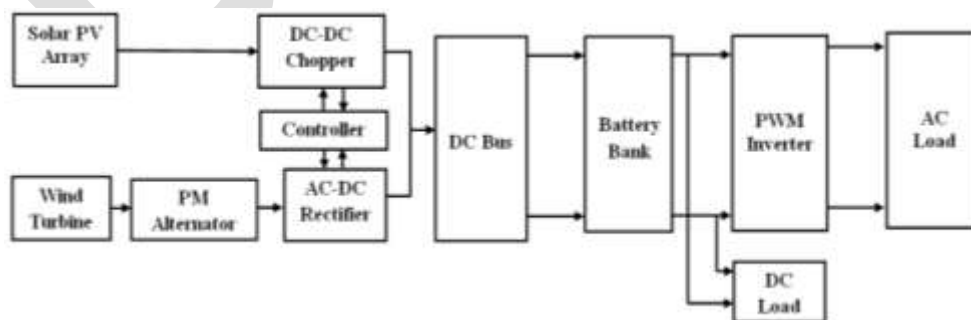


Fig. 1. Block Diagram of SWHP

## SYSTEM DESCRIPTION

The SWHP is made up of solar photovoltaic array, wind turbine generator, controller with the combination of PID/fuzzy/Neural Network, storage batteries, Rectifier, chopper, inverter, etc. as shown in Fig. 1. Rectifier used in wind Turbine line is to convert AC into DC. Chopper used in Solar PV line is to convert variable DC into constant DC. Then it is connected to batteries through charge controller. Here battery will ensure reliability of the power system for all climatic conditions. Batteries will charge when the power generation from wind and solar PV system is in excess and it will discharge when the power generation from wind and solar PV is not enough to meet the load demand.

Further battery makes the voltage of power supply steady. Fuzzy intelligence and NN controller are used to switch and regulate working state of batteries, so as to operate alternately in the state of charging or discharging. Thus the stability and continuity of power supply is improved. For the AC loads, PWM inverter is used to convert DC from battery into AC.

## SYSTEM MODEL

### A. Wind turbine generator model

According to aerodynamics principle, output power characteristic of wind turbine is described as follows [1,2] considering the main components of a wind turbine for modeling purposes consist of the turbine rotor, a shaft and gearbox unit, an electric generator, and a control system.

$$P_i = \frac{1}{2} \rho \pi \lambda C_p(\lambda, \beta) v^3 R^2 \qquad (1)$$

Where $C_P$ is a constant denotes wind power utilization coefficient, $\rho$ is the density of air, $v$ is the wind speed and R is the radius of wind turbine blades. The tip speed ratio of wind turbine is written as:

$$\lambda = \frac{R\omega}{v} \qquad (2)$$

Where $\omega$ is the wind turbine angular speed and the aerodynamic torque can be expressed as:

$$T_a = \frac{1}{2} \rho \pi C_T(\lambda, \beta) v^2 R^3 \qquad (3)$$

Where $C_T(\lambda, \beta)$ is the torque coefficient which is given by

$$C_T(\lambda, \beta) = \frac{1}{\lambda} C_P(\lambda, \beta) \qquad (4)$$

The fitting functions of $C_P(\lambda, \beta)$ is obtained by:

$$C_P(\lambda, \beta) = C_1(\frac{C_2}{\lambda_i} - C_3\beta - C_4)e^{\frac{C_5}{\lambda_i}} + C_6\lambda \qquad (5)$$

$$\frac{1}{\lambda_i} = \frac{1}{\lambda + 0.08\beta} - \frac{0.035}{\beta^3 + 1} \qquad (6)$$

Where $C_1, C_2 .... C_6$ are the undetermined coefficient according to characteristic of wind turbine.

### B. Photovoltaic cells model

The equivalent circuit of solar cell, composed of photo-generated current source, internal series resistance and parallel resistance, is shown in Figure 2.
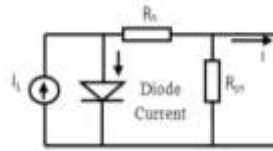
Fig. 2. Equivalent circuit of single photovoltaic cell

The relationship between the output voltage V and the load current I of a PV cell or a module can be expressed as

$$I = I_L - I_0 (e^{\frac{q(V-IR_S)}{nkT}} - 1) - \frac{(R_S I + V)}{R_{sh}} \qquad (7)$$

Here $I_L$ is the generated photocurrent under a given intensity, $I_0$ the saturation current of the diode, q the charge of an electron, K the Boltzmann's constant, n the ideality factor for a p-n junction, T the temperature rise, $R_s$ and $R_{sh}$ are the series and shunt resistance of the solar cell respectively.

The saturation current $I_0$ varies with corresponding temperature according to equations:

$$I_o = C_D T^3 e^{(\frac{-eE_G}{nkT})} \qquad (8)$$

$$I = 5.46 * 10^{-3} E_{tp} [1 + 0.001(T - 298)] \qquad (9)$$

Where $C_D$ represents the diffusion capacitance, $E_G$ represents the band-gap energy of the semiconductor used in the PV panel and $E_{tp}$ represents the intensity in mW/cm$^2$.

Dynamic models for the main components in the proposed hybrid system have been developed in MATLAB/Simulink platform. The developed model is utilized for a PV cell to investigate the system performance of intelligent power management strategy and it is shown in fig.3.
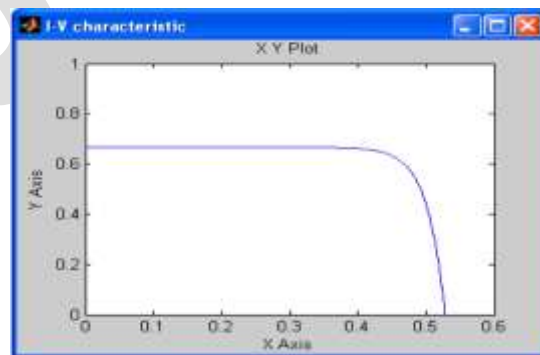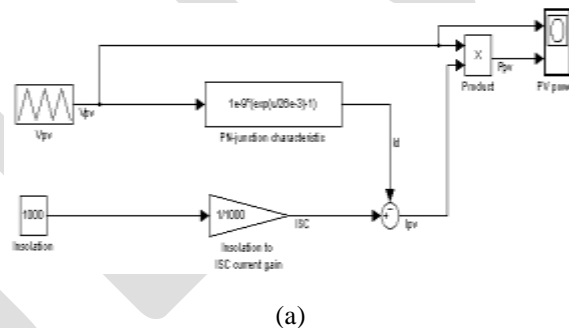


(a)



(b)

Fig. 3. Simulation of single photovoltaic cell (a) Simulation block diagram (b) I-V characteristic curve

*C. Storage battery model*

Thevenin Equivalent model of the storage battery is used in this paper as shown in Fig. 4. It comprises of voltage source Vs, battery internal resistance of $R_s$, equivalent parallel resistance and capacitance of R and C respectively between parallel plate electrodes. As all the parameters are constant, it may be an approximate battery model only.
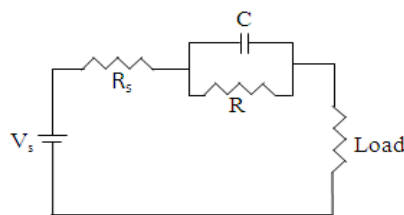


Fig. 4. Thevenin equivalent of battery circuit

# FUZZY-PID-NN CONTROL

*A. Control method*

Closed-loop control system with double loop is used in battery charge/ discharge of SWHP. Inner- loop is taken as charge current loop, PI control is adopted. Outer-loop is taken as charge voltage loop. It brings to the whole system; fuzzy-PID-NN is used to control respectively realized by a switch. In an initial stage of charge, PID control is adopted for realize the large current and fast charge. But when 80% to 90% of the battery capability is reached, charge mode is fuzzy logic/Neural network, and charge voltage is invariable. Schematic control system diagram is as shown in Fig.5
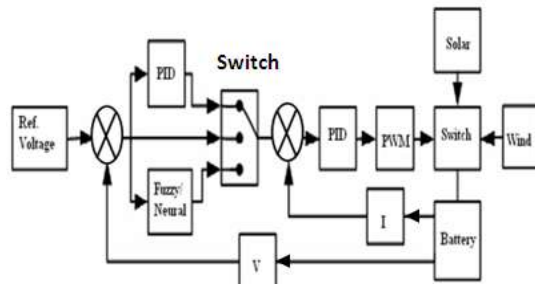


Fig. 5. Schematic control system diagram.

*B. Design of Fuzzy controller*

Fuzzy controller system is associated with artificial intelligence. Fuzzy variables of controller include the input variable e, Δe and the output U. e is taken as the deviation of reference and sampling voltage of batteries. Δe is taken as the change rate of change of e. U is taken as charge variable of batteries. Their domain is defined as follows:

$$e \in [-4,4],$$

$$\Delta e \in [-2,2],$$

$$U \in [20,24]$$

The corresponding fuzzy subset is as below:

$$e \in [NB, NM, NS, ZR, PS, PM, PB]$$

$$\Delta e \in [NB, NS, ZR, PS, PB]$$

$$U \in [NB, NM, NS, ZR, PS, PM, PB]$$

There are several methods to design a fuzzy controller. The design of fuzzy controller involves formation of membership function and rule base. Here, we have taken the rule base proposed by Mamdani for the simulation of the Fuzzy controller. These rules are shown in Table1. The table is read in the following way: If the error is negative small (NS) and the change of error is positive big (PB), then the control action is positive medium (PM).

| e △e | NB | NM | NS | ZR | PS | PM | PB |
|------|-----|-----|-----|-----|-----|-----|-----|
| NB | NB | NB | NB | NB | NS | ZR | PS |
| NM | NB | NB | NB | NM | NS | ZR | PS |
| NS | NB | NB | NM | NS | ZR | PS | PM |
| ZR | NB | NM | NS | ZR | PS | PM | PB |
| PS | NM | NS | ZR | PS | PM | PB | PB |
| PM | NS | ZR | PS | PM | PB | PB | PB |
| PB | ZR | PS | PM | PB | PB | PB | PB |

Table I: Rule base Fuzzy Controller (Mamdani)



Input variable "e"



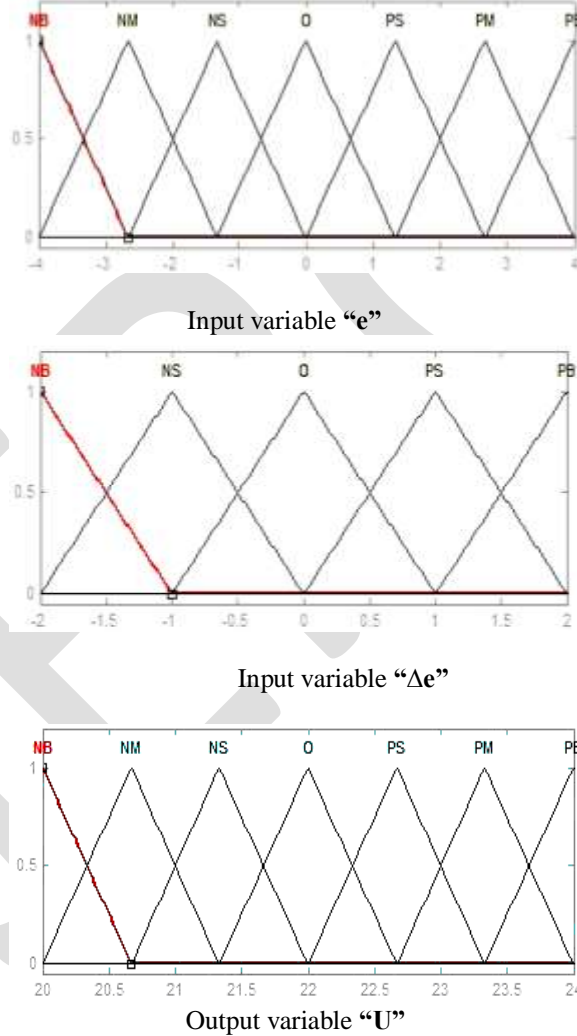Input variable "△e"



Output variable "U"

Fig.6. Membership function of fuzzy linguistic variables
  (a) Membership function of e
  (b) Membership function of △e
  (c) Membership function of U

In Matlab/Simulink, fuzzy variables, domain and fuzzy control rule are written in Fuzzy Logic Toolbox. The fuzzy inference system is Mamdani. The membership function of fuzzy variables is shown in Fig. 6.

*C. Design of Artificial Neural Network*

The Neural networks used here are basically layers of neurons connected in cascade, with one input layer, one or more hidden layers and one output layer. The input layer is the sensory organ for the Artificial Neural Networks. Each neuron in a layer is connected to an adjacent neuron layer with different weights. Each neuron, except for the neurons of the input layer, receives signals from the neurons of the previous layer, weighted by the interconnect values between neurons. Consequently the output layer produces an output signal.

The choice of the number of hidden layer nodes is a compromise between efficiency and accuracy. Satisfactory results are obtainable if the number of hidden layer nodes is equal to the number of output nodes. NN structure is utilized to compute the maximum battery power utilization by developing MATLAB/Simulink for solar and wind energy sources, which consists of solar PV, wind turbine coupled to a permanent magnet DC generator, battery storage unit, PID controller and PWM inverter.

Feed forwarded NN is trained to compute the efficient battery utilization of hybrid model of SPV and Wind Turbine for the given solar radiation and wind velocity. Fig 7 shows the trained ANN in MATLAB/Simulink environment.
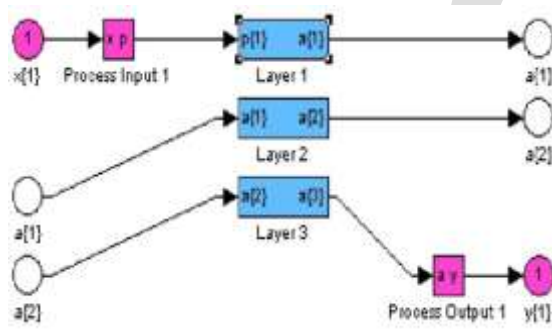


Fig 7. Trained NN model with Input, hidden and output Layer for SPV and wind Turbine system in MATLAB/Simulink platform

## SIMULATION RESULT

A series of simulation results are presented in this section based on the developed mathematical model of hybrid power systems using both Fuzzy logic and Neural network. The simulation parameters are listed in the Table II of Appendix. Simulink of the whole control system using fuzzy logic & Neural network is shown in Figure.8&9 respectively. The simulation results of hybrid system with fuzzy and Neural network is given in Figure. 10. It illustrates the output AC line voltage & rectified DC voltage of wind turbine generator and MOSFET gating input pulse of battery charge/discharge for a particular time period. From the figure, we understood that output AC line voltage & DC voltage of wind turbine is same for fuzzy logic as well as Neural network. But we can see the difference in gating input pulse of battery charge/discharge for fuzzy logic and NN.
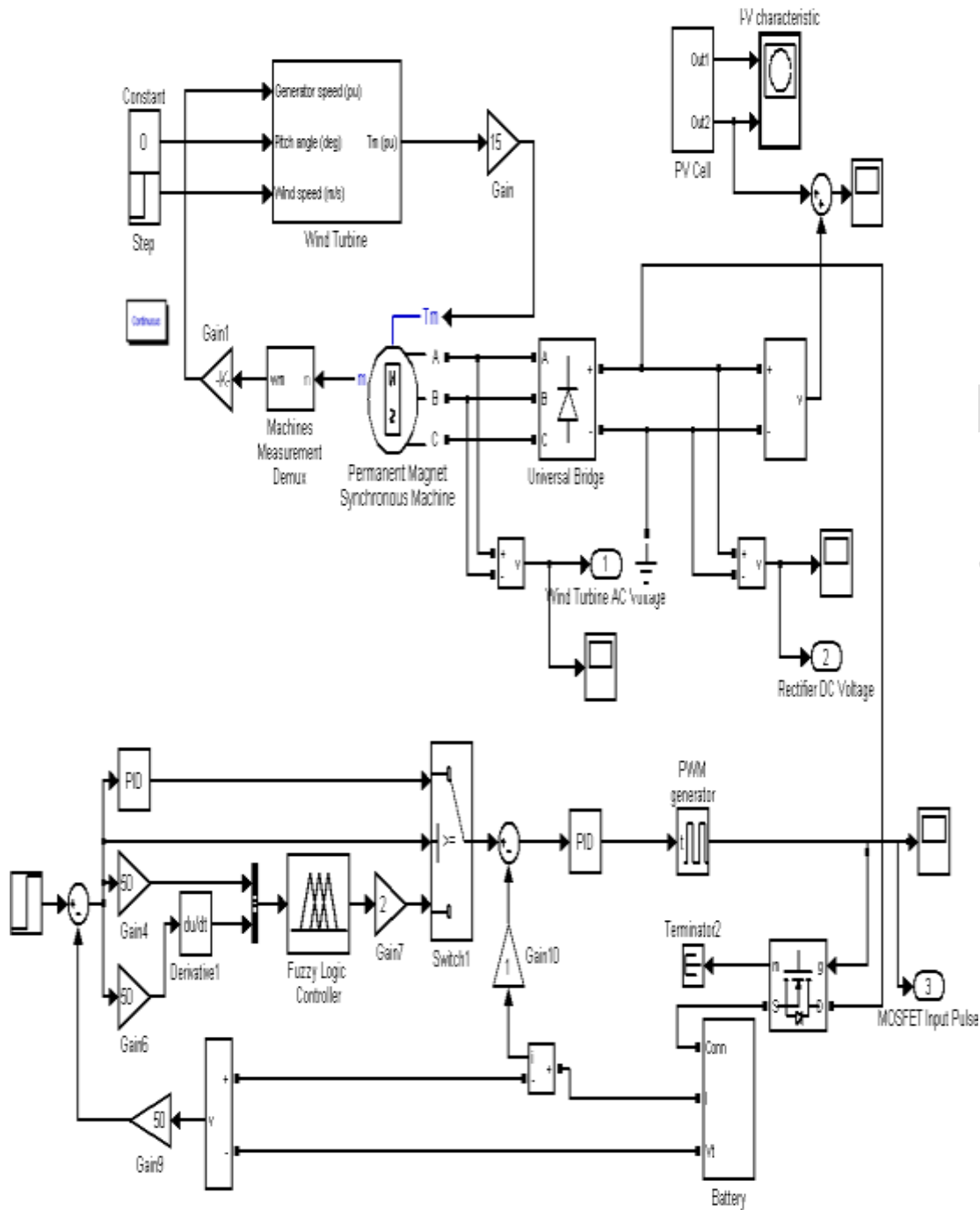
Fig. 8. Simulink of the whole control system using fuzzy logic
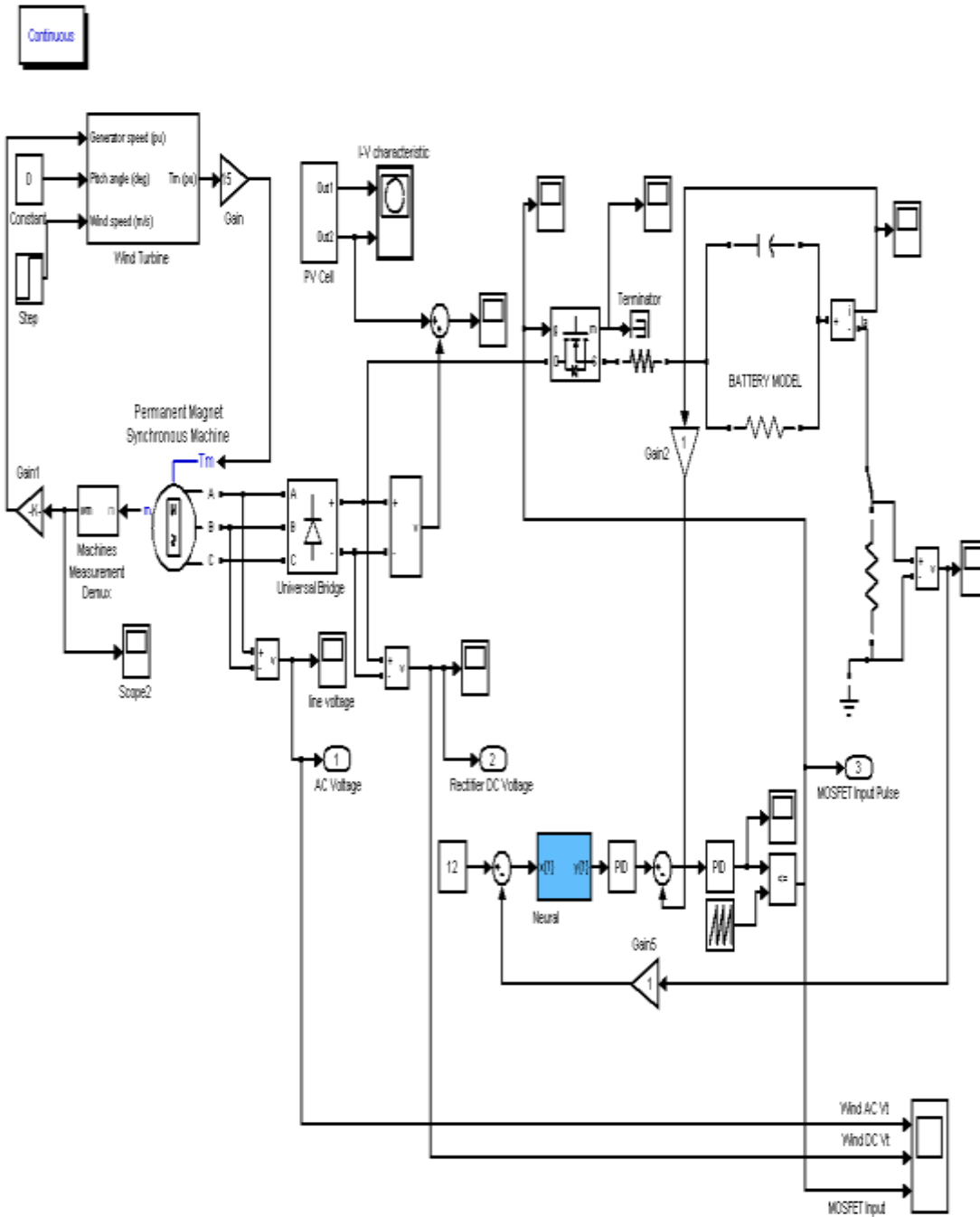
Fig. 9. Simulink of the whole control system using Neural network
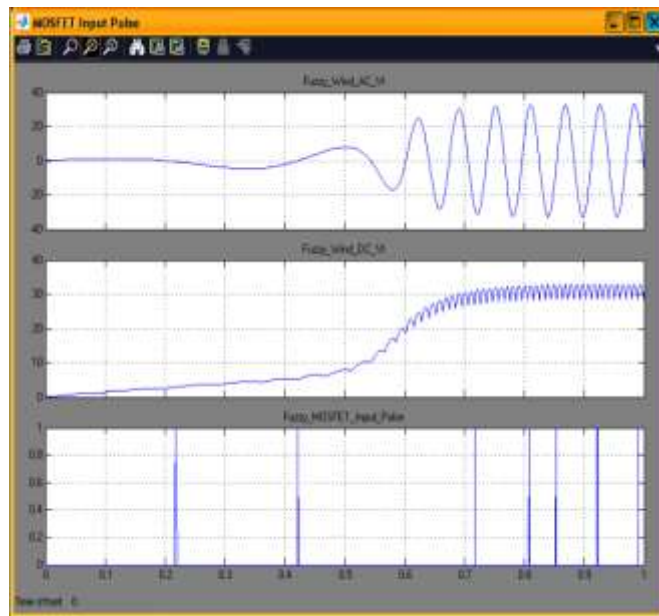
(a)
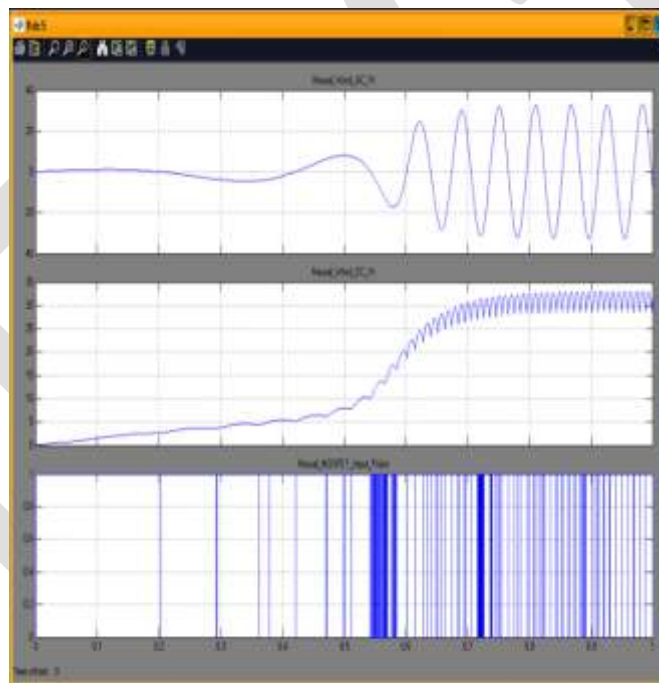


(b)

Fig. 10. (a) Simulation results of Fuzzy logic Control (b) Simulation results of Neural network System

## CONCLUSION

The simulation results of fuzzy-NN control based intelligent battery power management is discussed. Comparatively Neural network shows an improved version, compared to fuzzy logic in battery power management in the way of charging/discharging for a particular time period in SWHP. The proposed scheme can be applied to other similar power generation systems. It may be an approximate simulation as the model of battery is quite complicated. The simulation results will be more ideal if the model of battery is improved. Simulation result achieved from MATLAB/Simulink platform shows the effectiveness of the developed utilization of battery with

improved charging/discharging characteristic to meet large demand of industry/ domestic load.

## APPENDIX

TABLE II. SPECIFICATIONS OF SWHP COMPONENTS

| Wind Turbine | |
|---|---|
| Parameter | Value |
| Ratted output power | 300 W |
| Ratted wind speed | 12 m/s |
| Pitch angle | 0 |
| Solar PV | |
| Light intensity | 100 mW/cm$^2$ |
| Atmospheric temperature | 25 $^0$C |
| n | 1.11 |
| Rs | 0.141 ohm |
| Rsh | 2000 ohm |
| $C_D$ | 10 |
| Eg / eV | 1.13 |
| 200 Ah discharge Lead –Acid Battery | |
| Nominal capacity | 200 Ah |
| Nominal voltage | 12 V |
| Max charging current | 60 A |

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# Parts Handling Systems for Machine Shops of Small and Medium Enterprises

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**Abstract**— Low cost automation provides cost effective architectures and development approaches for transportation of components that properly integrate human skills and technical solutions. Most appropriate and judicious use of low cost material handling techniques become necessary to reduce the manufacturing cost, manufacturing cycle time, smooth material flow and remain competitive. This paper focuses on various issues typically faced by SMEs in handling parts during different stages of processing in a machine shop that houses a variety of machine tools.

**Keywords**— Low cost automation; Conveyors; Belt Conveyors; Roller Conveyors; AGV; Robots; Pallet Truck .

## 1. Introduction

The contribution of the small and medium sized enterprises (SMEs) to the industrial growth and economic well being of the nation often goes unnoticed and unappreciated despite of the fact that this sector provides for a large proportion of employment and feeds essential components to larger organizations. SMEs are also said to be responsible for driving innovation and competition in many economic sectors [1]. However, most SME's have to work with the following constraints from manufacturing stand point [2]:

- Less number of technically skilled manpower
- Limited funds available for the improvement
- Limited plant area
- Lack of advanced machineries & expertise

Automation is a means to improve the competitiveness by enhancing the productivity of the manpower and the equipment. This assumes special significance in the present context where small scale industries are facing high interest rates, shortage of skilled manpower and adherence to quality standards delivery schedules[3]. Procurement of sophisticated and highly automated new equipment becomes an expensive option as most SMEs invariably face financial crunch. They normally need lower budget modifications within the functional plant to improve the productivity. Focused efforts are thus required to improve the performance of this sector in respects of product quality and organizational productivity.

## 2. Low cost automation (LCA)

Low cost automation is an approach that permits enhancing the performance of existing facilities by incorporating simple mechanical, pneumatic, hydraulic or electrical systems and devices with low investments. The term 'low cost' is a relative quantification of cost incurred on renovation project [4][5].

Consistency of good quality and improvement of quality are the dominating demands of the time for survival of small scale and medium scale industries. Appropriate systems can be devised for parts handling automation on process machines or between operations for achieving smooth production flow, reducing manpower requirements, more consistent performance, reduced labour cost, achieving higher productivity and so on. This paper is aimed at providing a few guidelines in this context. It discusses merits, demerits and application situations for various material handling systems like conveyors, robotic handling systems, pneumatic systems, hydraulic systems, hoisting equipment, PLC based automation, retrofitting etc., currently used by various small scale industries, to reduce the inventory, for improved safety, for reducing damage and to improve material flow [6][7][8].

The real potential of low cost automation is not yet fully recognized in the small and medium scale industries. SME's are still dependent on manual work which causes drop in productivity. Low cost automation can be applied where manual work is being done for operations like material transfer, inspection etc. LCA is a continuous attempt to control mechanization and automation of certain work elements and is focused on prolonging the life and productivity of existing machine tools. It can be used to achieve quality in

production, to lower the physical efforts of workers, where high skilled labor is required, to get rid of manual loading and unloading and to lower the rejection rate. It has wide variety of application which depend on the type of SME's we are dealing with [9].

Selecting the right kind of systems thus assumes great importance when evaluated in terms of the returns on investment. A wrong decision may lead to lowering production rate, ineffective utilization of available space etc. Choosing a material handling system within a machine shop is one of the toughest things to do. Small scale industries may design new material handling systems which requires lower setup cost or they may do small modification in current setup of material handling system.

## 3. Material handling systems for SMEs.

The shop floor supervisor is the best agency to identify the potential areas of the application of LCA. Some of the low cost automated parts handling systems which are widely used in SME's are explained below.

## 3.1. Conveyors

Conveyors are primarily horizontal-movement, fixed-path, constant speed material handling systems. However, they often contain inclined sections to change the elevation of the material as it is moving, switches to permit alternate paths and 'power-and-free' capabilities to allow the temporary slowing, stopping, or accumulating of material [1].

Broad variety of conveyors is being used in industries for handling the products. Flat belt conveyors, troughed belt conveyors, closed belt conveyors, metallic belt conveyors, portable conveyors and submerged belt conveyors are the types of belt conveyors which are being used within the industries to transfer material between two machines or to travel the material to some destination. Similarly wide variety of chain and roller conveyors are also used in industries. These include apron or pan conveyors, cross bar or arm conveyors, car type conveyors, carrier chain & flat top chain conveyors, trolley conveyors, suspended tray conveyor (swing tray conveyors), unpowered / idle roller conveyors and powered / live roller conveyors. All the above systems are costly, huge in size and occupy large space besides reducing easy accessibility and free movement space between machines. This is a vitally important concern for SMEs considering the fact that they have few less floor space, limited work force and limited resources. Evidently, all type of conveyors can't be used. Conveyor systems which occupy less floor area, are light in weight and are easy to operate only need be used by the SME's[10][11].

## 3.2 Portable conveyors

Short length flat conveyors carried on a wheeled structure is termed portable conveyor. Portable conveyors are light in weight and compact in design and can easily moved to desired places as we need. Portable conveyor has features like high durability, high efficiency, sturdy construction and precision functioning.

Loading and unloading on trucks / transport vehicles can be easily done with portable conveyors. They are suitable for parts handling between adjacent processing machines. Portable conveyor's inclination can be adjusted to suit the need [1].

Fig.1. Portable conveyor

## 3.3 Roller conveyors.

A roller conveyor features unit type of load on a number of rollers in series, mounted on bearings. Rollers are resting at equally spaced side frames which are fixed to stands or trestles placed on floor at certain intervals. A roller conveyor essentially coveys unit loads with at least one rigid, near flat surface to maintain stability while conveying. Products like boxes, sheets etc. can be easily conveyed with the help of roller conveyors [1] [12].

Roller conveyors are classified into two groups according to the principle of conveying action. These are:

### 3.3.1. Unpowered or idle roller conveyor

Roller conveyors which don't need any external power source for the conveying are nothing but the unpowered or idle roller conveyors. Please see fig.2. The loads roll over the series of rollers either by manual push or push from an endless moving chain or rope fitted with pusher dogs, rods or clamps. Generally inclination of 1.5% to 3% is provided for easy rolling of the products. Products are conveyed with the help of gravitational force. Such conveyors are termed 'gravity roller conveyor' [13].

These are particularly used between machines, buildings, in warehousing as storage racks, docks, foundries, rolling mill plants, manufacturing, assembly and packaging industry. They are also used for storage between work stations and as segment of composite handling system. Rollers conveyors have few disadvantages like only flat surfaced objects can be conveyed, material can be transferred to only short distances etc. [14][15].
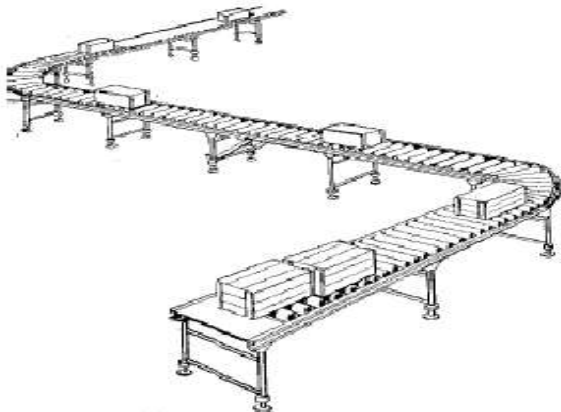


Fig.2. General view of an unpowered roller conveyor [1].

### 3.3.2 Powered roller conveyor

Powered roller conveyors, also called as live roller conveyors, have all or a few of the rollers (generally the first, the last and a few middle rollers) driven by one or multiple motors through associated transmission system like chain drives and belt drives. The loads on the roller conveyor are moved by the frictional force caused between the loads and the driven rollers supporting the loads.

Powered roller conveyors are intensively used where heavy weights are to be conveyed for long distances on the shop floor, especially in industries where there is problem of availability of work force [1]. Plant layout is required to be designed to optimize the length of the conveying system. Such systems can be used for SMEs for dedicated material handling when volume of production is high and product variability is very low [16].
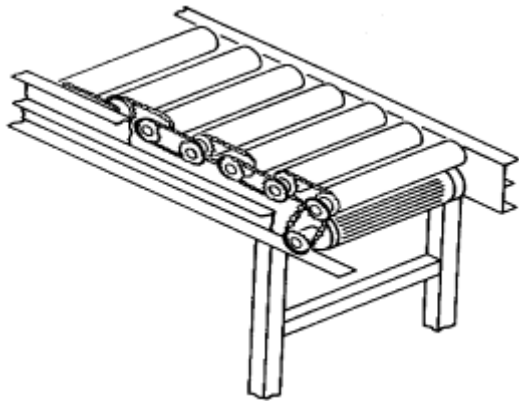
Fig.3. Powered roller conveyor

## 4. Automatic guided vehicles

An automated guided vehicle system (AGVS) is a material handling system that uses independently operated, self propelled vehicles guided along defined pathways. Driverless towing tractors guided by wires embedded into or affixed onto the floor have been available since the early 1950s. Today AGV's are competing with conveyors and other material handling system due to their advanced features like sensors, ability to take decisions, automatic path changing mechanisms etc. Most AGVs have only horizontal motion capabilities. Any vertical motion is limited [2][17].

Power for the automatic guided vehicle is usually a battery, like that of the electric industrial truck. Path guidance may be provided in several ways such as optical guidance, embedded wire system, laser beam guidance system, electrical guidance or magnetic guidance can be implemented in AGV's [2].

The directions that an AGV can travel may be classified as unidirectional (one way), bidirectional (forward or backward along its path) or omnidirectional (all directions). The AGVS which can travel along all directions and equipped with advanced technologies like microprocessors and sensors are also called as self guided vehicles (SGV's) and are provided with anti-collision systems to prevent damage to equipment and parts they carry[18].

AGVs and SGVs are not a convenient option to use for SMEs since they require dedicated isle spaces and often cost significantly. However, for manufacturing cells with CNC machines arranged in linear layout, simple AGV's systems can be a boon to SMEs. This would be particularly suited to cells where the CNCs perform multiple operations with a single parts setting and the station's total processing time (cycle time) is large. During this period, an AGV may be considered to work as shuttle for transporting parts from one machine to another while machines are busy processing parts.

## 5. Robots

Use of robots in industries is a common seen today albeit in SMEs. An industrial robot is an assemblage of links joined so that they can be articulated into desired positions by a reprogrammable controller and precision actuators to perform a variety of tasks like material transfer and inspection. Robots range from simple devices to very complex and ''intelligent'' systems by virtue of added sensors, computers, and special features [2][3]. The most obvious anthropomorphic characteristic of an industrial robot is its mechanical arm, which is used to perform various industrial tasks. Robots are of several types and models and are readily available in a wide range of shapes, sizes, speeds, load capacities, and other characteristics. Robot must be selected and specified to suit the kind of processing or handling application. Care must be taken to select a robot to match the requirements of the SME after thorough evaluation of the tasks to be done. Or else, it becomes one more case of selecting robot wrongly. Sensing and control technologies are well established and must be appropriately incorporated considering the application on hand. Robots, being programmable multi-jointed machines, fall between humans and fixed-purpose machines in their utility. In hazardous conditions like working in very high temperature or cold humans can't work properly. Humans can be replaced by an industrial robot which can work perfect in such conditions without spoiling quality of work [2][19].

For small and medium scale industries robots can be the best option over the other automated system. In SME's robots can be used to transfer materials in between two machines, within the single machine or for any kind of repeatable work. An industrial robot can increase the productivity of SME's to great extent rather they can reduce human interference within the production. Cost is the dominating reason for its not being favoured much. However, for situations where production rate is high (low cycle time) and the

operation is largely pick & place type, use of simple robot is suggested for low weight components. By middle of this decade, many of the SME's may think of setting up robots within their manufacturing facilities [20].

## 6. Hydraulic pallet trucks

Pallet trucks are either motor operated or manual low-lift machines designed to raise loaded pallets sufficiently off the ground to enable the truck to transport the pallet horizontally. Pallet trucks are widely used material handling device and well known for its flexibility [2] [21].

The hydraulically operated pump and handle assembly enables the operator to manually operate and propel pallet truck, raise the truck forks, and push/pull the load. Electric-battery-powered pallet trucks, available in motorized versions, are equipped with dc electric motors to electrically raise and transport parts. The power supply for these trucks is an on-board lead-acid traction battery that is rechargeable when the truck is not in use [2].

Extensive use of pallet trucks in SMEs is recommended in view of their low cost, easy availability, low maintenance and suitability to handle a wide variety of jobs. Human effort for handling heavy jobs is considerably reduced. Even if manual pallet trucks don't provide any automation, they still remain the most accepted material handling device in SMEs.
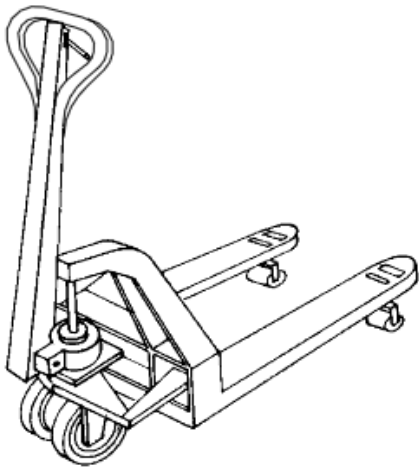


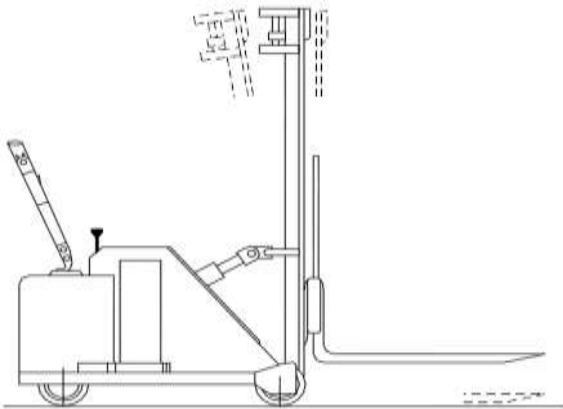Fig.4. Manually operated and propelled pallet truck [2].



Fig.5. Counterbalanced electric-battery-powered pallet truck [2].

## 7. Hydraulic and pneumatic parts handling systems

The rapid development of electronic interfacing technology had seen the proliferation of electro-hydraulics and electro-pneumatics devices. Fluid, electric and solar powers are some of the energy technologies used for driving modern automated systems. Of these technologies fluid power is mainly reserved for traditional utilization. Hydraulic power is normally used in mechanisms and pneumatic power for sequential automated process.

Various combinations of hydraulic and pneumatic attachments can be used to bring the automation in SME's like pneumatic or hydraulic clamping devices, hydraulic pallet trucks for material handling, rotary indexing tables etc. SME's can implement these types of hydraulic and pneumatic attachment devices to either existing machines or in completely new setup.

## 7.1 Hydraulic parts handling systems

Hydraulic systems usually convert the mechanical energy from an electric motor to fluid power. A positive displacement pump is used to increase the pressure of a hydraulic oil, generally petroleum based.

Hydraulic material handling system includes devices like electric hoists, scissor lifts, portable cranes, hydraulic pallet trucks, jib cranes, drum trolleys, fork type drum trolleys, trolleys and weavers beam trolleys. By using high pressure, the size of component becomes small and the system becomes very compact which is good for small scale industries where work area is limited.

## 7. 2  Pneumatic parts handling systems

Availability of high pressure air for operating clamping devices, various tools, cleaning etc in a manufacturing establishment is universal. Extensive use of compressed air for actuating mechanical systems for gripping, pushing, tilting, lifting and similar several operations is suggested. Pneumatically powered mechanical handling are required to be built for handling machine parts and components on machine tools and between machines, by the SMEs.

In pneumatic systems, instead of oil under very high pressure, air at a much lower pressure is used. Similar to hydraulic systems, here too valves, pipes and cylinders are needed. Pneumatic systems are very popular for low cost automation since the cost is much less than that of hydraulic systems. Apart from this, pneumatic material handling systems are easily distinguished for various advantages such as abundant availability of the operating medium (air) in contrast to costly oils used for hydraulic systems, easy control over leakage problem, safety in operation, high speed of operations etc [22].

Pneumatic material handling systems such as vacuum transport (used to transport powder and granulated materials), air slide conveyors (used to transport fined grained particles with high capacity) etc are used in hi-tech industries. Vacuum systems can be manufactured for single or multipurpose applications. System can be also built as independent portable units. Materials most suited for handling are ash and cement.

Pneumatic material handling would be money consuming for small and medium sized enterprises because of high initial investment in equipment. It still, in some special cases, would be the most effective and productive method of handling machined parts. In fact, pneumatic systems present a plethora of ideas on which innovative parts handling systems can be developed for any machine shop. All that is needed is identifying a problem situation and finding standard pneumatic manipulating system to match the need.

## 8. PLC (Programmable Logic Controller) for LCA

Early PLC's were only capable of ON/OFF control, being specifically developed for applications limited to repetitive processes like automated transfer lines, SPMS (special purpose machines), and batch process sequencing. A programmable logic controller can be defined as microcomputer based controller that uses stored instructions in programmable memory to implement logic, sequencing, timing, counting and arithmetic functions through digital or analog input/output modules, for controlling machines and processes [3][23].

To meet the demands of harsh industrial environments, PLCs are designed to be extremely robust, often capable of withstanding extreme temperatures, humidity, vibration, and electrical noise. Logic controllers are commonly tasked with monitoring and controlling a very large number of sensors and actuators, and are therefore distinct from other computer systems in their extensive input/output (I/O) arrangements.

High-speed sorting on conveyors, image-processing inspection, bottle filling control, air cleaner control, sheet feeding control in packing machine, testing equipment, conveyor positioning control, basic conveyor rail width positioning, production line conveyor shift unit etc. are few of the hundreds of applications of PLC's [24].

PLC system can be easily implemented in small and medium scale industries to improve the production rate to great extent. PLC systems are well developed and easily obtainable from service providers at reasonable cost. It's a definite and sure way to control production machines, automate inspection and achieve repeatability.

## 9. Conclusion

It is seen that umpteen opportunities exist in SMEs to upgrade and improve existing facilities by making use of low cost automation strategies. Most of the material handling systems in SMEs continue to function for several years, as initially installed, just because the same remain uninvestigated with an eye on improving quality and productivity. Scenario can be improved drastically through simple solutions and making use of some innovative ideas and available resources.

Application of LCA calls for systematic data collection, its analysis and finding a technical solution for every conceivable problem area across the plant. This however is not a simple job. Various factors are required to be considered by dedicated task teams for selecting a material handling system for a machine shop and other possible LCA solutions. Part geometries, weight of parts handled, distance between workstations, time required for manufacturing, cycle time, available work space etc. are some of the important factors which must be assessed to evaluate the cost benefits as also various tangible and intangible gains, as outcome of the proposed strategy.

It would be readily noticed that, with relatively low investments, LCA systems certainly enable the managements to lower the workers involvement in material handling. This automatically lowers the part rejections, improves safety and reduces accident rate, nurtures productive ambience and contributes significantly to product quality and organizational productivity.

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# Designing Facilities Layout for Small and Medium Enterprises

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**Abstract**— — Facilities layout is a systematic and functional arrangement of different departments, machines, equipments and services in a manufacturing establishment. It is vitally important to have a well developed plant layout for all the available resources in an optimum manner and get the maximum out of the capacity of the facilities. The problem is of particular importance for Small and Medium Enterprises (SMEs) because of major constraints that include cost and space. Selection of right method is a very important step in layout design. In this paper methods of layout design are discussed taking into consideration the specific issues and limitations of SMEs.

**Keywords**— Facilities Layout; Layout Problems; Computer Aided Layout Planning; Evaluation Methods, Simulation

## INTRODUCTION

The most crucial element that affects efficiency of a production process is the facilities layout. A good layout keeps costs low and reduces unnecessary material handling while maintaining the product flow through the facility. Improving the layout also increases the machine utilization that enhances the machining capacity of the shop floor. Quite often, the management feels the need of redesigning plant layout even when the things are apparently going smoothly for the company. One of the reasons for designing a new layout may be improving the performance of the existing plant. Upgrading the facility by replacing old facility with more advanced machinery is also necessitated many a times [1]. In both the cases the performance measures being targeted for improvement need be identified clearly.

An enterprise is considered as an SME based on the annual sales turnover or number of full-time employees of a unit which is a small number, not exceeding 50. The majority of workers are invariably semi-skilled and required to work on more than one machine. Most of SME faces the problem of unsafe movement of operator from one machine to another. It is desired to arrange the machines in such a way that single operator can easily and safely move to number of machines [2]. Improving the layout to get better utilization of machine and operator need lean thinking.  Redesigning an existing layout calls for a critical consideration of several key factors including the 13 factors suggested by Apple [3].

The common thing about the all available methods of plant layout development is that they develop number of alternate layouts. The selection of best among these layouts is based on certain evaluation methods. Each plant layout design technique has its own and different evaluation method. Each evaluation method is based on single performance measure. It is therefore very necessary to decide and fix the performance measure has to be improved for designing a new plant layout. The objective of the layout design has to be very clear as it helps in deciding the best method to implement for improved layout design. Further, one must evaluate the proposed layout and compare it with existing layout, based on the chosen performance criterion. In SME's the nature of plant dynamic i.e. there is frequent change in the demand and scheduling is very complicated. Measuring the performance becomes very difficult by direct mathematical calculations. Use of simulation tools for measuring the performance is suggested by some investigators [4].

It is seen that for designing a new layout it is very important to know the problems faced by the SMEs, the available techniques of layout design, use of simulation in layout design and evaluation methods. These are discussed next.

## LAYOUT PROBLEMS

The facility layout problem is concerned with finding the most efficient arrangement of individual departments with unequal area requirements within a machine or facility. The objective of the facility layout problem in SME, therefore, is to minimize the material handling costs inside a facility subject to two sets of constraints: (1) department and floor area requirements and (2) department location restrictions. These constraints include:

1  Departments should not overlap
2  .All departments must be located within the facility
3  Location of some departments is pre-fixed due to processing sequence
4  Some sections are not allowed to be placed adjoining specific locations
5  Floor loading and
6  Floor-to-ceiling clear-height in multiple-floor facilities. [5]

Earlier the facility layout is considered to be static, that is once the layout is planned and executed it is not changed for many years. Now a days that trend is changed, with continues improvement in the technology management had to update the facilities with time. The task of designing a dynamic layout becomes even more difficult when multiple objectives have to be achieved. [6][7]

With the increasingly diversified demand in the production, most of the manufacturers are using mixed-product assembly lines (MPAL's). The design of the assembly line has to take this evolution into account. An MPAL is a production line capable of producing a variety of different product variants simultaneously and continuously. Stations are flexible enough to perform their respective tasks on different variants. The most common problems seen with MPAL's are:
1. Generic product modelling,
2. Line balancing,
3. Resource planning, and
4. Resources allocation to the workstations in order to balance the workload along the line.

Resource planning is concerned with the selection of production means which are adequate for performing the assembly operations specified by the assembly planning. Model launch is based on schedule of the different models to be produced during the course of work shift. [8].

Bottleneck is one of the major problems faced by most SMEs in manufacturing parts that necessitate machining operations. Reason of occurrence of bottleneck is mainly due to improper sequencing of facilities within the work area. Bottlenecks should be eliminated in any operation because it severely affects productivity and throughput improvement of the plant. [9]

The facility layout problem is a common industrial problem in which the objective is to configure facilities so as to minimize the cost of transporting materials between machine tools and other processing operations such as welding. Fig. 1 highlights what seems to constitute essential features to characterize layout problems [10].
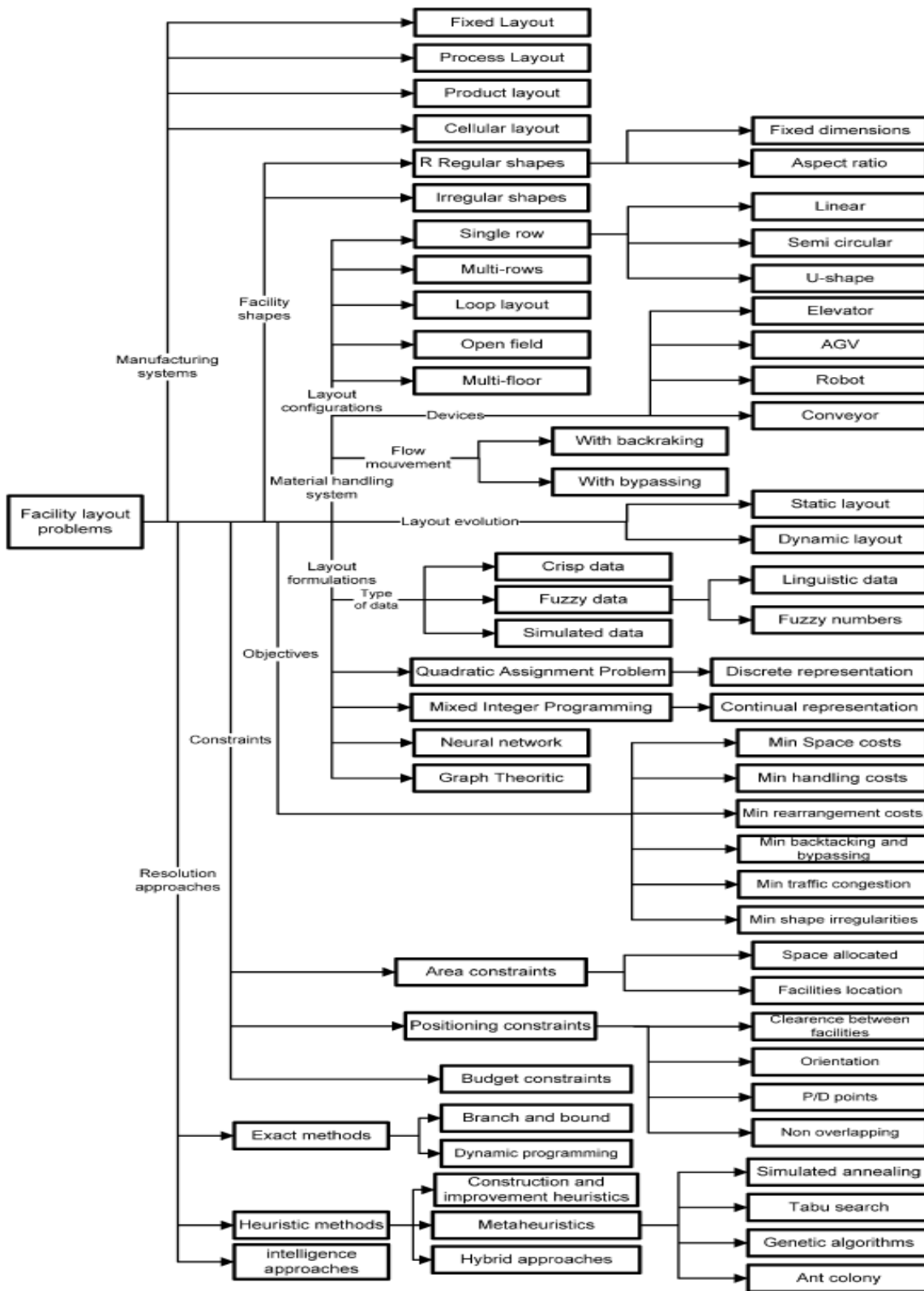
Fig. 1 Tree representation of the layout problems [10].

## LAYOUT DESIGN TECHNIQUES

Plant layout design is very old concept and considerable research has already been done in this area. With the time elapsing, various techniques and software tools are now available. The following are some of the well known techniques currently employed for the plant layout design.

## Manual Method

Traditionally, scale templates of various departments are prepared as per dimensions or area requirement and are adjusted by the designer in the available space. The effectiveness of this method is dependent on the designer's experience and judgment. This method is, therefore, not being preferred these days for designing a layout.

## 1. Systematic Layout Planning (SLP)

Muther [3] has proposed a methodology to design plant layout based on analysis, search and selection procedure as shown in fig. 2. The alternative layouts generated by this method are based on block diagrams. The space relationship diagram is constructed by replacing the unit squares with space templates. For each activity, a space template is constructed to scale, to represent the size and shape of the activity. Since different shapes can have same area, it is possible to construct different space relationship diagram from the same block diagram. This method also relies heavily on the capabilities of the designer. It can, however, prove quite effective if proper care is taken in arranging the templates.
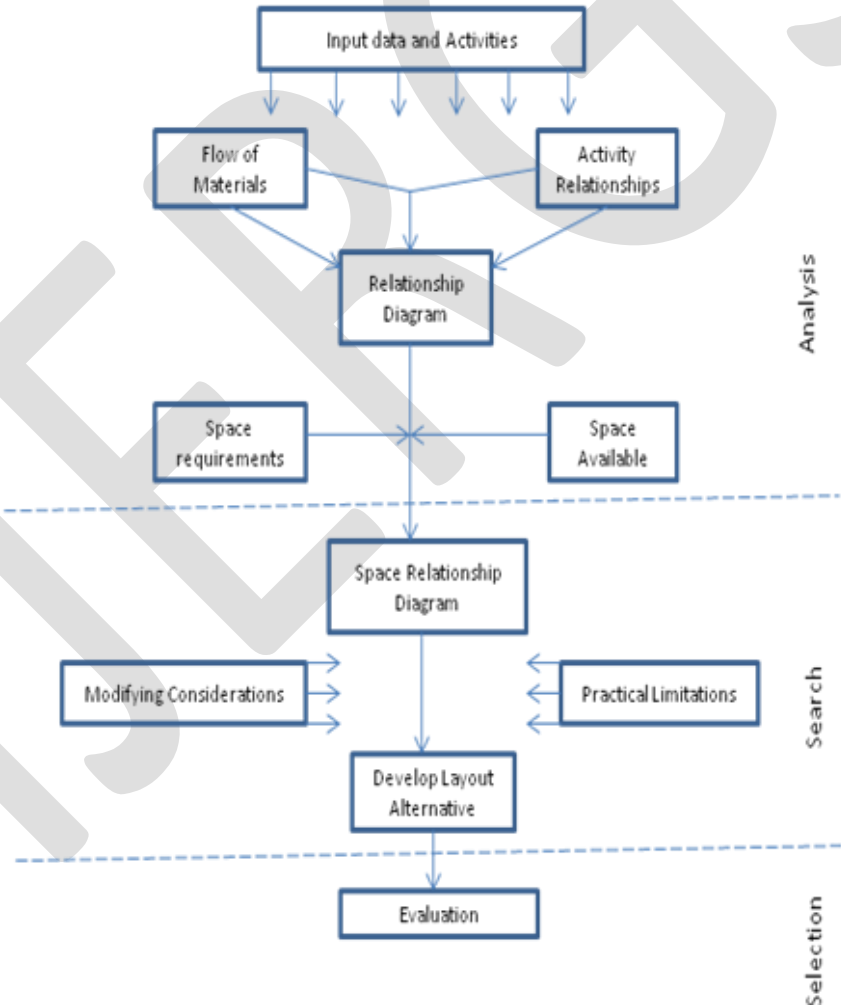


Fig 2. Systematic layout planning [3]

An important consideration in plant layout design is the human comfort. This should be maximized while minimizing at the same time the distance between the facilities. The human factors which need attention in developing machining facilities include work

environment with human body posture, stress and other physiological capacities of the work force. Successfully achieving such human factors enables good working conditions which are conducive for reduction in injuries, effective and highly productive environment and reduced fatigue.  It is found that these goals are fairly well achieved by using SLP that takes into consideration the human factors [11]. The SLP has been found to improve spatial distances between facilities (machines, between workstations and between departments) and also improve the flow of material through the plant. Thus cost of material handling is reduced significantly [12].  As a consequence, less material handling time is needed, workers move faster and the overall productivity increases. [9][13][14][15]


## Computer Aided Plant layouts

### 1.      ALDEP  (Automated Layout Design Program)

ALDEP is construction based algorithm and is used when activity relationship is a major consideration. It develops a layout design by randomly selecting a department and placing in the layout [16]. The departments are placed in layout based on its closeness rating. Layouts are evaluated by adjacency score i.e. totaling the numerical values assigned for adjacent departments closeness rating. In the layout generated by ALDEP, departments have unusual shaped borders. Since evaluation is based on only one parameter, namely the effectiveness of the layout proposed, this method has not received good acceptance.

ALDEP is generally used for developing a new layout. It is not convenient for redesigning and improving the existing layout. It can, however, be of assistance in generating a large number of alternatives layout solutions all of which can then be evaluated separately. It is not found adequate for reducing the material travel distance across the plant.

### 2 CORELAP      (Computerized Relationship Layout Planning)

CORELAP is also a construction algorithm with activity relationship a major consideration. It is designed to accommodate situations when constantly changing conditions prohibit the collection of precise numerical data. [16]

CORELAP constructs layouts by locating rectangular-shaped departments when the departmental area and layout scale permit a rectangular representation of the departmental area. It is based on REL chart and numerical weighted rating assigned to the closeness ratings. The evaluation phase employs a placing rating and a boundary length.

Total closeness rating for each department is calculated as:

$$TCR_i = \sum_{J=1}^{m} V(r_{ij})$$

m = no. of departments

The TCR rating is the sum weighted rating between the new department and its neighbors in the layout. Boundary length refers to the length of the boundaries common to the new department when all departments are accommodated in the layout.

CORELAP is a deterministic approach that provides an unique solution. Running the program second time with the same data produces the same final layout. The rectangular shape of the departments is divided into predefined number of square blocks. In order to make department rectangular the user has to increase or decrease the area of the department which results in over or under-utilization of the floor space. Unlike SLP the generation phase of the layout is carried by this technique without any involvement of the designer. Once the relevant input data and information is entered, the entire layout development work is fully performed by the program. There is a high possibly that layout generated by CORELAP is not practically implementable.

An updated version of CORELAP, named INTERACTIVE CORELAP, has been introduced recently to overcome these limitations. It allows the user    to make fine adjustments at intermediate stage of the layout development. The layout generated by this version doesn't have rectangular configurations that eliminate poor space utilization exist in previous version. Evaluation is based on score which is the shortest rectilinear distance between the borders of all pairs of departments multiplied by the numerical values of the closeness rating between the departments.  It gives more realistic layouts since the layout user is a part of the decision making process and operational difficulties can be taken care of to some extent due to possibility of intervention at the intermediate stage.

### 2.      CRAFT (Computerized Relative Allocation of Facilities Technique)

CRAFT is based on improvement algorithm. It is applicable for improving performance of the existing plant.  It is used when reducing the material handling cost is the main objective of layout design.   The locations of activities (departments) are interchanged in the existing layout to improve the layout.    CRAFT is a suboptimal, heuristic procedure which produces a layout that cannot be easily improved upon further.

Generation of layout is based on total distance traveled by the material. It first evaluates a given layout and then considers the effect if the department locations are interchanged.   Only departments with common borders or of the same area are considered for exchanges

of locations.    If an improvement becomes visible due to pair wise exchange, the exchange producing the greatest improvement in chosen.    The approach provides the flexibility of retaining the existing locations of certain departments in the layout being developed. This can be a matter of great convenience to SMEs. In a typical example of the job shop layout, it is shown that the revision has yielded a reduction of 52% in the total distance traveled by the product as compared to the earlier layout when replaced with the cell type layout generated by CRAFT [17]. The CRAFT can also be used in cell layout to solve the problem associated with the total material traveled. [18]

The use of CRAFT program does not guarantee that the least-cost layout will be found, since all possible interchanges are not considered. It is the most widely used technique for layout design. SME's in particular desire that the process of layout redesign is quick and efficient since they cannot afford their limited human resource continue to remain unproductive for long periods of time. The changeover has to be executable quickly and at a little cost.

## 4. AUTO LAY 2010

It is software that generates plant layouts automatically and compares all layouts on the basis of their effectiveness and cost incurred.    Inputs required are relationship code, relationship value and area of each department and equipment. First the user of the program has to input the relationship code which can be gathered from the relationship chart known as REL chart. By entering the area required by each department or facility program computes the number of unit square needed for each department. The computed numbers of squares are used to indicate each facility. Further, the user has to specify the relationship value allotted to each priority code. Program calculates the total closeness relationship value for each section and by combining these values the score of the existing layout is determined. Based on the specified closeness relationship value nodal diagram is generated. By replacing the nodes with the computed number of unit blocks alternate layout is developed. The effectiveness value and relative cost of the generated layout is computed. Similarly, an array of layouts is generated till an optimum effectiveness value and transportation cost combination is achieved. The following relationships may be used.

Generation of square blocks for grid:

No. of blocks $(B) = A/q^2$
A= area of dept.
q= block dimension

Distance effectiveness value:

$$\sum_{i=0}^{n} \sum_{j=0}^{m} G_{ij} \, d(k_i, h_j)$$

Where:
n, m =  number of  department in row, column
$G_{ij}$   = Activity relationship rating
D    = rectilinear Distance between station I and j.

Relative cost:

$$\sum_{i=0}^{n} \sum_{j=0}^{m} C_{ij} \, d(ki, hj)$$

where $C_{ij}$ = Projected Transportation Cost of setting dept i beside j

If the designer desires to make any changes in the layout proposed by the program, he has the option to interchange nodes as deemed fit. The program allows for incorporating such changes. However, the program is unable to handle and accommodate all the constraints envisaged in designing a layout.

Application of AUTO LAY 2010 to an Aluminum product factory has shown that cost of transportation in has been reduced. With just 50% less movement cost, the new layout is now more efficient and cost effective [19]. Similar results have been observed when this tool is used for a process based firm. Its effectiveness for the product based firm, such as a typical machine shop, is required to be validated.

## SIMULATION

The process of layout design is necessary in order to improve the performance of the existing layout or for solving certain problem related with the layout. To evaluate whether the said objectives would be achieved by the new layout, it is essential to measure the performance of the existing layout and the proposed layout. Static performance measures are easy to calculate by simple formulations. There are some measures which are time dependent that is the number of accidents, annual production level, number of batches waiting for processing and many more. These time dependant measures are not deterministic due to dynamic behavior of the plant [20]. The actual model building can take months and cost a company plenty of money. After modeling it may be found that the new layout doesn't meet the desired expectations. The process of layout design is required to be repeated until a satisfactory layout is obtained.  Using simulation software is the way out to quickly model and test the layout economically.

One of the best tools available to provide correct evaluations of system interdependencies is discrete event simulation. With the use of this simulation technique, manufacturers are able to quickly and accurately model future proposed modifications to their facilities without making costly guesses. It saves time and money in modeling the layout, and enables testing the performance. The models being created not only serve the initial purpose of determining buffer space and resource levels, but also permit  evaluation of new cuttings on a regular basis [2][21]. This multi-functionality feature has turned the simulation models into an operational planning tool and has brought facilities planning directly to the plant floor where the everyday engineer can evaluate changes quickly and accurately. The multi-purpose plant model is now becoming the norm rather than a farfetched dream when evaluating new product flows on the plant floor [4].

The objective of the simulation exercise must also be clear. The focus primarily is on minimizing travel distance and material handling cost. Simulating the layout after design phase is better when applied to deterministic problems with predefined operational policies and production strategies. However, simulation, followed by design, is best applied for problems exhibiting uncertainties and those where the objective is to justify production strategies and improve layout operational parameters [22]. By observing the above, it can be readily seen that using simulation prior to and after the layout generation is the best approach. This provides for straight forward evaluation of the alternative layouts made a available by the program. One can chose the best layout based on the predefined objective or performance criterion [9].

## DISCUSSION

Unquestionably, selection of proper technique is a very important step in the layout design. Every available technique has its own benefits and limitations. There is no method which can be a alchemy solution the entire layout problem. The selection of technique is dependent on the plant constraints, size of firm and objective of design. The final layout given by the computer program may not be best design, as computer programs are optimization techniques based on certain algorithms which may not be practical or those not able to take care of all the eventualities. The computer programs are better than the traditional methods as they form an array of layouts very quickly and are not dependent of capabilities of the designer. Performance of each alternate layout can be evaluated by simulation and one can select the most appropriate layout by comparing the performance of the each layout considering the objective of the layout design.

In this paper efforts have been focused on finding the most suitable method to design layout for SME's. As discussed earlier, the major constraints in the SME's are that they have limited capital and space. For choosing the best technique, the designer has to first think on whether the firm is product based or process based. Basically for product based firms minimizing the distance between the facilities along with maintaining smooth flow of material is considered. While for process based firm closeness relationship of a facility with all the other facilities is main concern. Comparatively more facilities are required to be accommodated in the available space.  This means that the process of layout design should be simple and such that hiring a specialist layout designer becomes unnecessary.

The most common objective of layout design, that is to minimize distance traveled, is not always suitable for all the SME's. Some congestion in a specific area may have to be tolerated while maintaining minimum separation between facilities.     Instead of criterion of minimizing total distance travelled, one may wish to minimize the maximum distance travelled [1].

## CONCLUSIONS

It is noticed that the performance of SME's can be improved even with some redesigning the existing layout. A careful study can make it possible to just change the process layout into a cell layout. It is more beneficial to first form cells and then design a layout using CRAFT. For the SME's where cell formation is not possible, CRAFT can be used by replacing the department with facilities and layout of plant with departments. Working on this program is easy and simple. Anyone who has basic computing knowledge can work upon the problem of layout planning. The process of designing a layout for SMEs should be as follows: Collect the data; decide the objective of layout design; compute the performance of the existing layout using simulation; generate alternate layouts by using layout generation technique; again evaluate the performance of each alternate layout and select most optimal layout by comparing performances. SMEs would be benefited immensely if clear design procedures and simulation software are made available to them. Extensive application of simulation techniques is suggested for improving plant layout and enhances productivity.

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