# Technological Advancement In Enviornment Friendly De-Inking Process For Quality Improvement And Cost Optimisation

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**ABSTRACT**

Emami Paper Mills Ltd. installed a 2 loop DIP from Voith,Germany with a capacity of 300TPD to produce quality newsprint from standard furnish of 70% ONP & 30% magazine. While designing, and making layout, it was ensured to achieve the highest level of operational efficiency with the optimum yield and other quality parameters of strength and brightness. We are happy that the plant achieved highest level of operational efficiency with regular out put of 320 MT pulp and feeding the pulp to 2 Paper machines to produce news print of international quality. The best achievement is in the specific power which we could do at 285 kWh / T of pulp. The sludge generated from DIP is thickened in an imported Screw press and fired in boiler along with coal.

**INTRODUCTION**:

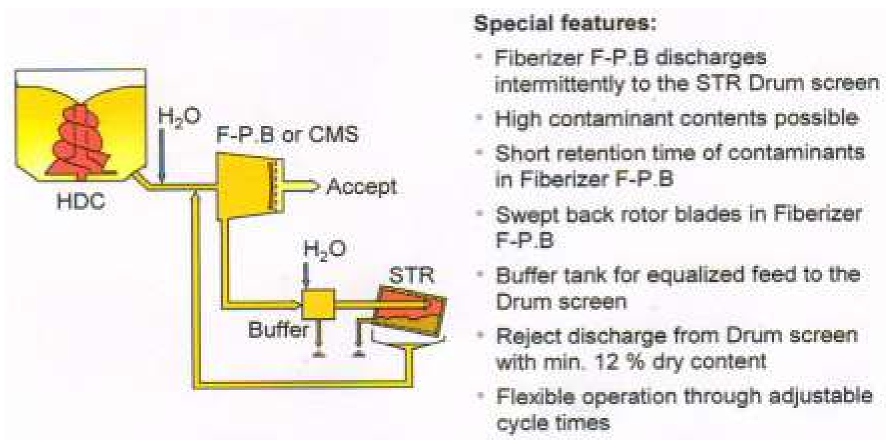
PROCESS DESCRIPTION:

Deinking Plant is equipped with High consistency pulping, High density centricleaning, Combiscreening, Heavy weight centricleaning, Preflotation, Fine Screening, dispersion system, Oxidative Bleaching, Post flotation & Reductive bleaching system. The Whole system is operated through completely automated system (DCS from ABB).

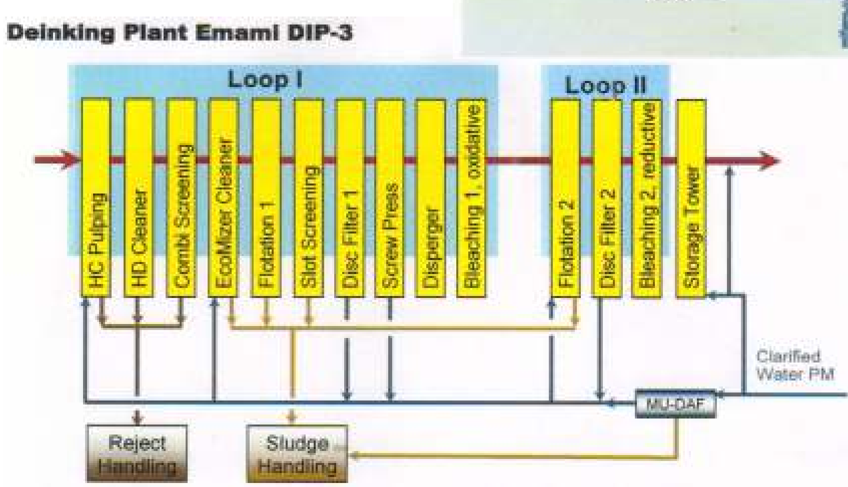
**Major advanced technological equipments:**

**PULPING SYSTEM:**

Principal components are HC-Pulper, Fiberizer & Screen drum.








**PROTECTOR SYSTEM:**

Separation & removal of heavy reject by centrifugal forces. Protector system is a 2-stage high density cleaning system. The first cleaning stage using the high density cleaner is operated with an inlet stock consistency of ~3.5%, where as the second cleaning stage using the low density cleaner works with a inlet stock consistency of ~ 1.6%.The high density cleaner accept is going forward to the hole screen 1st stage, rejects discharged towards the sedimentation tank, diluted to ~1.6% consistency in the sedimentation tank the heavier particles can sediment to

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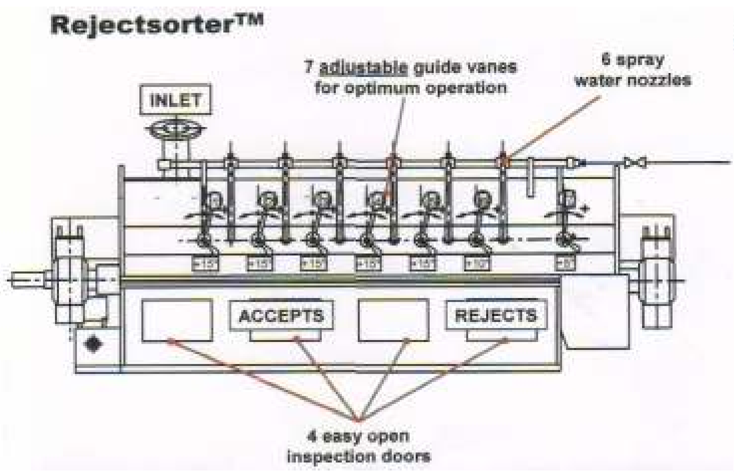
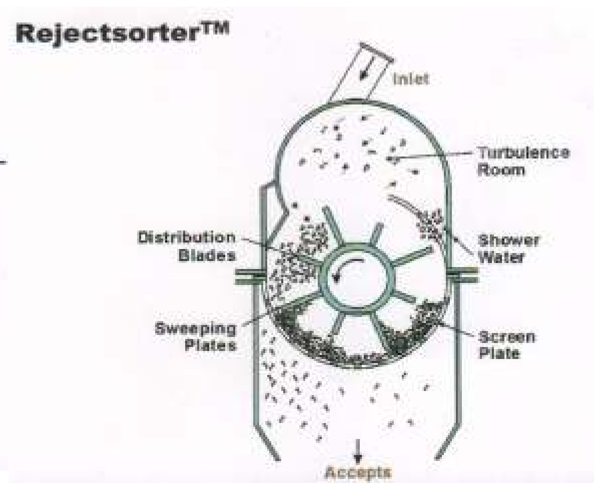



the bottom of the tank & are dumped by the junk trap. The fiber stock suspension from the sedimentation tank goes directly to the inlet of the second cleaner stage equipped with one cleaner with fiber recovery module & reject trap. In the fiber recovery module dilution water is added to the concentrated heavy particles to minimize the fiber losses. The accept flow of the second cleaner stage is going back to the dump tower.

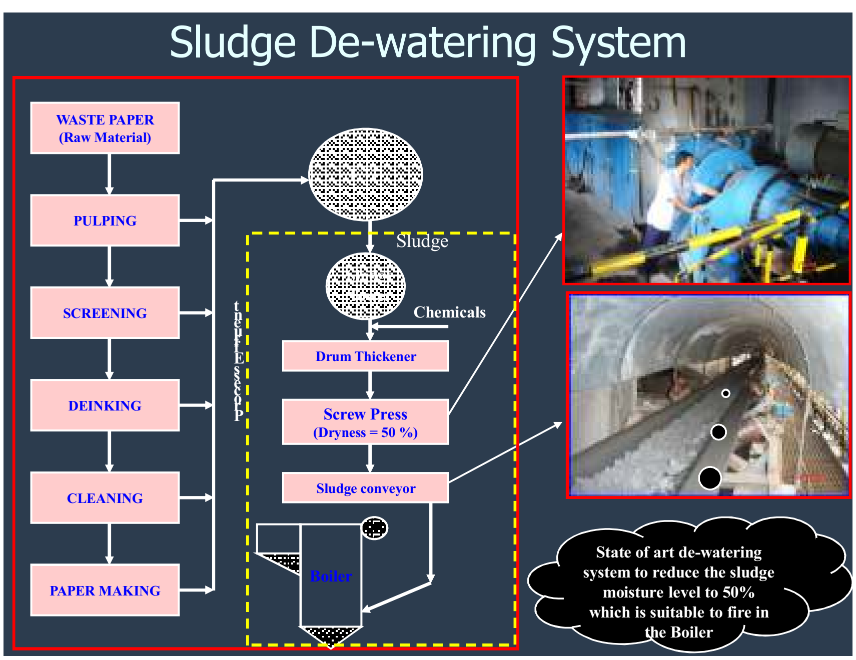
## COMBISCREENING:

The combi-screening is a three stage medium consistency hole screening system and a part flow two stage intermediate consistency slot screening system. The two stage hole screening system operates at a high consistency of around 3.5% in the first stage, 3% in the second stage & 2.3% in the third stage contains. $1^{st}$ stage multisorter, 2nd stage multisorter (1.2mm perforation), 3rd stage reject sorter (2.2mm perforation).The accept of $2^{nd}$ & $3^{rd}$ stage hole screens is fed to the $1^{st}$ stage slot pressure screen which operates at a consistency of 2% & the second stage slot screen at 1% consistency (Perforation 0.2mm each). The third stage reject sorter is gravity fed & fully enclosed tailing screen which operates at an inlet consistency of 2.5% & reject consistency is between 10 30 %.

## SLUDGE DE-WATERING SYSTEM:

The de-watered sludge from the Screw Press is used as a fuel in the boiler. EPML has also installed a high pressure co-generation boiler of 85 tph, operating at 64 kg/cm2 (g) pressure and 490 $^{0}$C steam temperature. The boiler has been designed for co-firing of sludge and coal. The boiler structure, the feeding mechanisms and the control system for the boiler have been designed accordingly to facilitate dual fuel firing.

- The dewatering system consists of Drum thickener & Screw Press; it brings down the moisture content of the waste sludge from 96% to below 50% by using suitable polymers thereby making it suitable for utilization as a fuel in the boiler.
- This results in conservation of non-renewable natural resource- coal.




## LITRETURE REVIEW

### DE-INKING

Objective: To remove printing inks & other substance which affect the properties of final Paper.

If improper removal of inks is taking place than it will result in lower brightness with dirt & specks in final paper.
Ink particles above 50 microns are visible as black or colored specks in the paper. Smaller ink particles lower the brightness of paper. In de-inking process, the ink should detach from the fibers at Pulper and floatation separates the ink and fibers from each other. Effective de-inking of ONP and magazines can increase the brightness by 15-19% ISO including 2 stage bleaching.
In the pulping stage use of caustic causes the fiber swell so the printing ink is released easily. Sodium Silicate

stabilizes the ink dispersion, chelate polyvalent metal ions and gives additional alkalinity .De-inking chemical detaches the ink from fibers.

In flotation air is injected in to a diluted fiber suspension of 0.8 to 1.5 consistencies. The water repelling ink particles attach to the air bubbles and rise to the surface and hydrophilic fibers remain in the water phase. The foam that contains ink can be removed by over flow.

## BLEACHING:

**Oxidative Bleaching**: In case of **hydrogen peroxide bleaching**, per hydroxyl anion acts as a nucleoiophilic bleaching agent. To achieve a high bleaching; increasing its concentration is essential, which can be done by increasing the peroxide concentration and by adding alkali (NaOH). This is an activation of the hydrogen peroxide.

$H_2O_2 + H_2O \leftrightarrow HO_2^- + H_3O^+$

$H_2O_2 + OH^- \leftrightarrow H_2O + HO_2^-$

At low alkaline dosages i.e. before the maximum bleaching results occur, the peroxide bleaching liquor does not have sufficient activation. In the highly alkaline range, i.e. after exceeding the optimum a loss of brightness occurs with additional sodium hydroxide due to the increased yellowing reactions of excessive hydroxide ions on the lignin structures of mechanical fibers.

A possible alkaline yellowing during pulping due to the absence of peroxide is compensated by bleaching after de inking. A higher content of ink particles will give a poorer bleaching effect.

**Reductive bleaching**

The reductive effect of the sodium hydrosulphite during bleaching is due to its chemical transformation in aqueous solution into sodium bisulfite ($NaHSO_3$) and into the sodium salt of the unstable sulfoxylic acid ($NaHSO_2$).In the presence of reducible substances, the reaction occurs as follows

$Na_2S_2O_4 + H_2O \leftrightarrow Na\,HSO_2 + NaHSO_3$

The Sodium salt of the sulfoxylic acid is the actual bleaching agent. In the presence of oxygen, the sodium salt oxidizes immediately into acid bisulfate (($NaHSO_4$) :

$NaHSO_2 + O_2 \leftrightarrow NaHSO_4$

This useless consumption of bleaching chemicals is accompanied also by a shift of the pH into the acidic area. Sodium hydrosulphite solutions can also decompose as a result of the exclusion of air especially at higher temperatures. The sodium salt of the sulfoxylic acid then transforms into sodium thiosulfate ($Na_2S2O_3$) according to the following:

$2NaHSO_2 \leftrightarrow Na_2\,S_2O_3 + H_2O$

To stabilize the sodium hydrosulphite solution, adding alkali as NaOH or $Na_2CO_3$ (5% - 7%) on a dry basis is recommended.

Sodium bisulfite was frequently used to destroy and prevent a carryover of residual peroxide. This approach is being replaced increasingly by closed process water loops that ensure the unconsumed chemicals are reintroduced into the process for reuse. Because flotation de- inking usually occurs between the oxidative and reductive bleaching stages, the strong dilution with subsequent thickening prevents a carryover of process chemicals from the previous process stages. Simultaneously, this causes a more favorable pH range for hydrosulphite bleaching even without additional acidification. In addition to this Bisulphite also agglomerates stickies in the system.

## RESULTS & DISCUSSION:

## PROCESS OPTIMIZATION:

### Flotation cell adjustment

Quality-wise the accepts of the secondary cells and the stock from the previous system should match at any time. If not the process will enrich itself with ink which is not rejected and finally the efficiency of the flotation will drop to a lower level. The effect of the soap dosing to the foam tank improved the secondary flotation to a more stable and better efficiency. This can be seen by the comparison of inlet flotation ink brightness and sec cell accept brightness as shown in Table No: 1. The soap has also a certain damping effect which enables the flotation cell to stabilize the ink variations caused due to the furnish.

## ENERGY SAVING

Power consumption was reduced from 350kwh/T of pulp to 285kwh/T of pulp, & steam consumption reduced from 550kg/T to 450kg/T of pulp by running the plant with 110% efficiency, changing the disperser tackle design & various in house measures as given in Table No: 2.

## SLUDGE DEWATERING SYSTEM

1. Sludge feed consistency optimization: It has been observed that higher & lower consistency increases the polymer consumption. Improper mixing in case of high consistency & more volume of sludge due to low consistency increase the polymer consumption.
2. By introducing online dilution system to get polymer concentration approx. 0.3gpl and simultaneously increased the dosing point for better mixing.
3. As per our R&D study, addition of concentrated Sulphuric acid and ferric alum @ 5.0 to 6.0kg/T BD sludge (each separately), into the sludge improve the flocculation efficiency and reduces the polymer consumption.(Table-3)

## COST OPTIMIZATION IN DE-INKING:

## DE-INKING:

1. Reduction of De-inking and bleaching chemicals - saving Rs. 350 / T of Pulp.
2. Energy Saving (Table-2)
   - Reduction of Power Consumption From 350 kWh to 285 kWh / Ton of Pulp
     - Saving Rs. 305 / Ton of Pulp
   - Reduction in Steam consumption From 550 kg to 450 kg / Ton of Pulp
     -Saving Rs 55 per Ton of Pulp.

## SLUDGE DEWATERING SYSTEM:

1. Reduction in Polymer Consumption From 4.0 kg to 2.0 kg / Ton of BD sludge
   -Saving Rs 250 / Ton of BD sludge.

## ENVIRONMENTAL MEASURES:

**Sludge Burning in Boiler:**

Earlier the sludge from the primary clarifier used to be dumped for land filling or some quantity used to go for mill board (sundry) manufacturing. With the Environmental impact of dumping the sludge in land, Emami decided to have a specially designed Power Boiler to accommodate the sludge to fire at dryness level above 50 %. We are happy to declare that we are firing 100 % primary sludge in the Power Boiler.

## Environmental Benefits:

1. Reduced coal consumption in the boiler also leads to a reduction in local air pollutants (like $SO_2$, $CO_2$, NOx and SPM) generation thereby improving the local air environment as well.
2. Avoided land fills which eliminates land pollution & fouling of near by areas.
3. Spreading of contamination to near by areas and ground water system during rainy season is also avoided.

## CONCLUSION:

1. Using standard furnish 70% local ONP: 30% Imported magazine, we are able to produce superior quality clean (dirt & specks free) de-inking pulp of 60 to 61% (ISO) Brightness.
2. Dirt & sticky removal efficiency are 96.0% & 98.0% respectively Table No: 4.
3. De-inking & bleaching cost reduced by Rs. 350/T of BD pulp by process & chemical optimization.
4. De-inking plant is producing pulp more (regular out put 320TPD) than the designed capacity (300TPD) with specific energy consumption of 285kwh/T & 450kg. Steam/T of pulp.
5. DIP is in operation with a latest state of art automation technology with minimum manpower.
6. Sludge De-watering system installed and commissioned successfully. We are proud to state that we are the first paper industry in India using 100 % DIP & ETP sludge along with coal as a fuel in the Boiler. By that we are reducing the GHG emission and preserving the natural resources and environment.
7. Efficiently operating the sludge de-watering system with a minimized chemical consumption.

## EXPERIMENTAL:

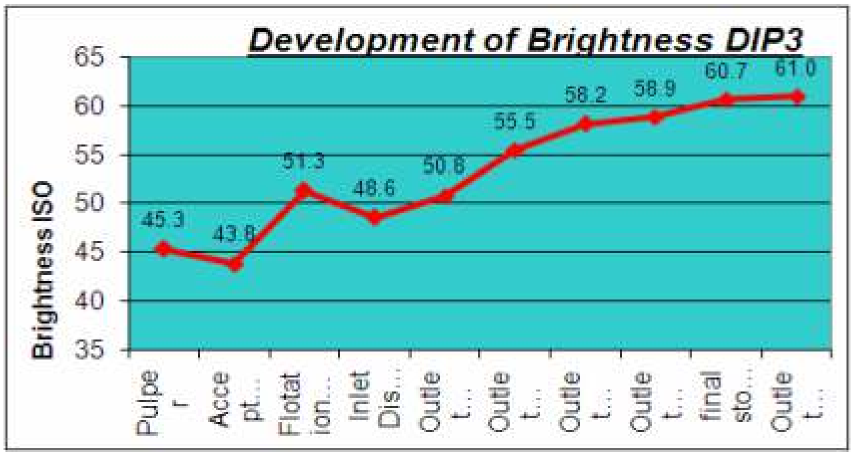
**1. Brightness stability Plant Trial:**

Before the experiment, soap was added to inlet of primary flotation cells, results analyzed in laboratory & found that secondary flotation cell accept was reducing the inlet brightness of Primary Flotation.

Experiment has been conducted in the Lab flotation cell by adding soap to secondary flotation accept. Based on

### Table No: 1

| | BEFORE SOAP ADDITION TO FOAM TANK | | AFTER SOAP ADDITION TO FOAM TANK | |
|---|---|---|---|---|
| **Pulping time:** | 08 Minutes pH= 9,1 | | 08 Minutes, pH= 9,1 | |
| ***Stock samples:*** | Consistency | Brightness | Consistency | Brightness |
| Pulper | 15.6 | 45.3 | 15.7 | 42.8 |
| Accept Hole Screening | 3.8 | 43.8 | 3.2 | 42.3 |
| Flotation 1 outlet | 1.27 | 51.3 | 1.25 | |
| Inlet Disc filter 1 | 1.07 | 48.6 | 0.96 | 51.2 |
| Outlet Screw press | 30.6 | 50.8 | 28.9 | 51.2 |
| Outlet Bleach tower 1 | 4.1 | 55.5 | 4.55 | 55 |
| Outlet Flotation 2 | 1.27 | 58.2 | 1.2 | 58.1 |
| Outlet (mat) Disc filter 2 | 15.6 | 58.9 | 14.44 | 57.5 |
| final stock (O/L bleach tube) | 9.34 | 60.7 | 9.07 | 61.7 |
| Outlet Storage Tower | 6.11 | 61.0 | 5.8 | 62.4 |
| ***Flotation trials*** | | | | |
| ***Flotation 1 (DIP3)*** | | | | |
| Accept Cleaner 1st stage | 1.72 | 41.5 | | 45.9 |
| Inlet Primary Cell 1 | 1.18 | 40.6 | | 43.4 |
| Accept Primary Cell 1 | 1.33 | 43.1 | | 47.5 |
| Accept Primary Cell 2 | 1.22 | 46.1 | 1.31 | 49.1 |
| Accept Primary Cell 3 | 1.27 | 46.1 | | 48.4 |
| Accept Primary Cell 4 | 1.17 | 48.9 | | 51.7 |
| Accept Primary Cell 5 | 1.22 | 48.2 | | 51.6 |
| Accept Primary Cell 6 | 1.22 | 49.7 | | 52.5 |
| Foam Primary Cells (mixture) ; with flocculant | 1.1 | | | |
| Inlet Secondary Cell 1 | 1.1 | 25.4 | | 26.4 |
| Accept Secondary Cell1 | 0.92 | 29.2 | | 35.6 |
| Accept Secondary Cell2 | 0.8 | 34.2 | | 37.2 |
| Accept Secondary Cell3 | 0.65 | 40.8 | | 46.3 |
| | | | | |
| ***Flotation 2 (DIP3)*** | | | | |
| Outlet Bleach tower | 4.59 | 51.2 | | 53.7 |
| Inlet Primary Cell 1 | 1.22 | 50.3 | | 53.1 |
| Accept Primary Cell 1 | 1.42 | 51.9 | | 52.6 |
| Accept Primary Cell 2 | 1.57 | 52.2 | | 55.4 |
| Accept Primary Cell 3 | 1.55 | 54.9 | | 55.5 |
| Accept Primary Cell 4 | 1.54 | 55.5 | | 55.7 |
| Accept Primary Cell 5 | 1.41 | 54.2 | | 56.8 |
| Foam Primary Cells (out of foam tank 1 drain); with flocculant | 1.07 | | | |
| Inlet Secondary Cell 1 | 1.39 | 37.8 | | 39.5 |
| Accept Secondary Cell1 | 0.98 | 41.7 | | 44.9 |
| Accept Secondary Cell2 | 0.91 | 46.5 | | 49.7 |
| Foam Secondary Cells (mixture); with flocculant | | | | |
| LAB FLOATATION TRIAL | | | | |
| ***For Primary Flotation 1*** | | | | |
| Inlet Lab.-Flotation | 1.2 | 41.5 | | |
| Accept after 6' | 1.12 | 46.5 | | |
| Accept after 12' | 1.09 | 48.8 | | |
| Accept after 15' | 1.04 | 49.7 | | |
| Accept after 20' | 0.95 | 50.8 | | |
| ***For Primary Flotation 2*** | | | | |
| Inlet Lab.-Flotation | 1.2 | 53 | | |
| Accept after 6' | 1.06 | 57.5 | | |
| Accept after 12' | 0.75 | 58.8 | | |
| Accept after 15' | 0.96 | 58.9 | | |
| Accept after 20' | 0.76 | 59 | | |
| ***For Secondary Flotation 1*** | | | | |
| Inlet Lab.-Flotation (out of foam tank 1 drain) | 1.1 | 27.5 | | |
| Accept after 2' | 0.79 | 34.1 | | |
| Accept after 4' | 0.54 | 41.5 | | |
| Accept after 6' | 0.46 | 45.8 | | |
| Accept after 10' | 0.31 | 48.6 | | |
| ***For Secondary Flotation 2*** | | | | |
| Inlet Lab.-Flotation (out of foam tank 2 drain) | 1.1 | 39.4 | | |
| Accept after 2' | 2.67 | 45.6 | | |
| Accept after 4' | 2.64 | 50.7 | | |
| Accept after 6' | 1.64 | 54 | | |
| Accept after 10' | 1.12 | 57.5 | | |


Development of Brightness DIP3
Brightness ISO
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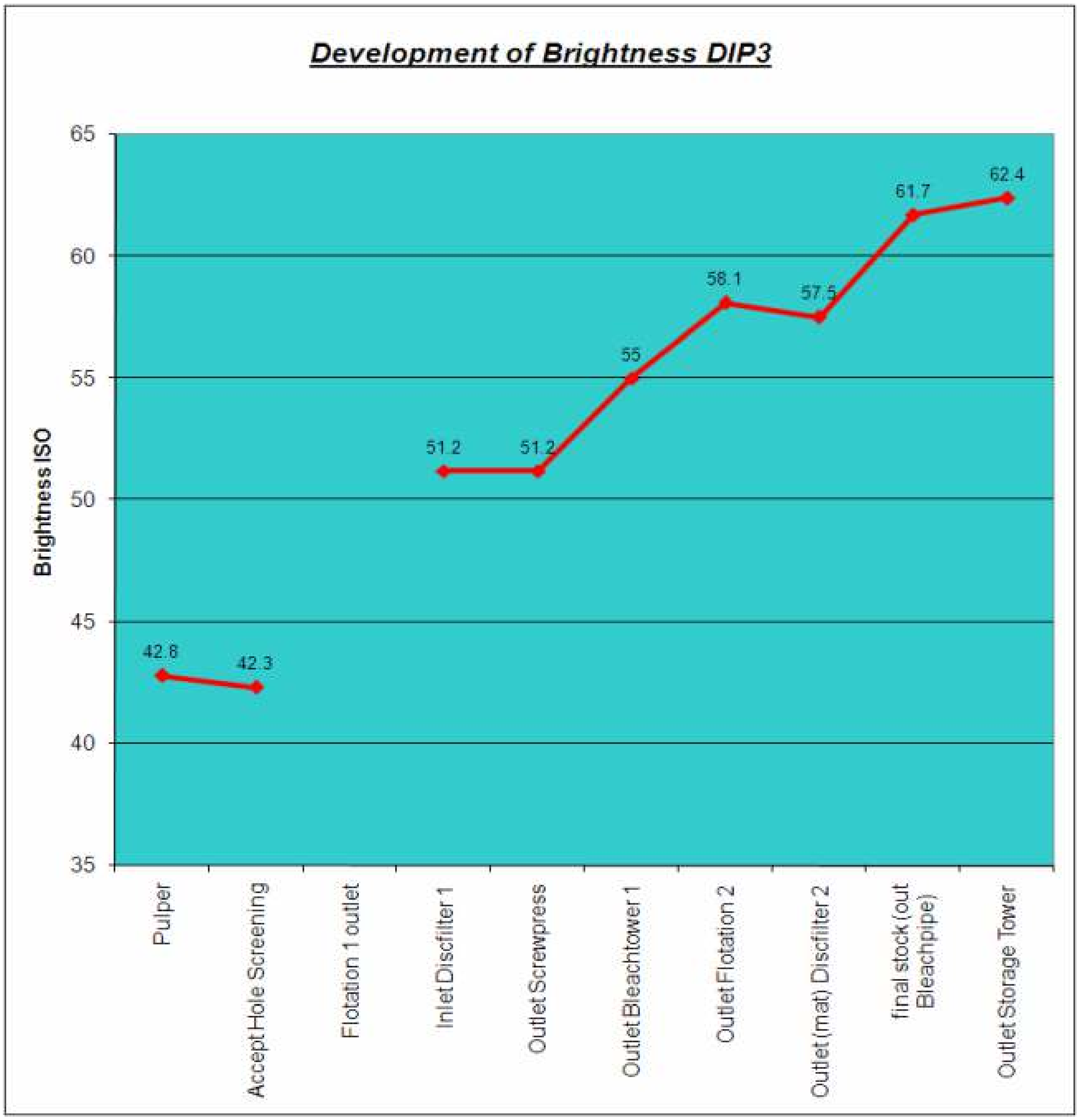
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55
58.1
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61.7
62.4
Pulper
Accept Hole Screening
Flotation 1 outlet
Inlet Discfilter 1
Outlet Screwpress
Outlet Bleachtower 1
Outlet Flotation 2
Outlet (mat) Discfilter 2
final stock (out Bleachpipe)
Outlet Storage Tower

**TableNo:2**
**Energy Saving in DIP**

| SL.NO. | DESCRIPTION | UNITS/TON OF PULP SAVED |
|---|---|---|
| 1 | STOPPAGE OF EP-71 PUMP (RATING: 45KW) BY INTER CONNECTION WITH KP-41. | 2.5 |
| 2 | STOPPAGE OF KP-31 PUMP (RATING: 22KW) BY INTER CONNECTION WITH KP-41. | 1 |
| 3 | STOPPAGE OF LP-41 PUMP (RATING: 75KW) BY INTER CONNECTION WITH LP-33. | 4 |
| 4 | SLUDGE PUMP- SP-11 (RATING: 75KW-INITIALLY) MOTOR REPLACED BY 30 KW BY CHANGING THE PUMP. | 4 |
| | TOTAL SAVINGS DONE | 11.5 |
| 4 | DISPERSER TACKLE DESIGN CHANGE | 30 |
| | TOTAL POWER SAVED | 41.5 |

**SLUDGE DE WATERING CHEMICAL OPTIMIZATION**
**TABLE-3**

| | PH | Cationic Demand as meq / lit | Nature of Flocculation |
|---|---|---|---|
| ETP + DIP Sludge + Polymer | 8.4 | -1082 | Normal |
| Sludge + Acid ($H_2SO_4$) + Polymer | 6.9 | -815 | Good |
| Sludge + Alum + Polymer | 6.9 | -730 | Good |
| Sludge + Acid ($H_2SO_4$) + Alum + Polymer | 6.9 | -700 | Very Good |

**Dirt & Sticky Count**
**Table 4**

| Dirt & Stickies count | | | | | | |
|---|---|---|---|---|---|---|
| Time | Inlet Holescreen | Storage Tower | | Inlet Holescreen | Storage Tower | |
| | Dirt Count | | Reduction | Stickies Count | | Reduction |
| | mm2/m2 | mm2/m2 | | mm2/kg | mm2/kg | |
| 9:00 | 880 | 12.5 | | 5622.19 | 24.34 | |
| 11:00 | 759.2 | 96.5 | | 11931.21 | 518.6 | |
| 13:00 | 773.7 | 13 | | 5418.37 | 71.83 | |
| 15:00 | 868.7 | 3.9 | | 2171.86 | 66.96 | |
| 17:00 | 586.5 | 12.7 | | 6858.48 | 2.53 | |
| 19:00 | 644.3 | 16.5 | | 4922.36 | 60.25 | |
| Average | 622.18 | 25.85 | | 6154.078333 | 124.09 | |
| Area in 24 h | 211292328 | 7297455 | 96.55% | 2089925002 | 35438676 | **98 %** |

the experimental results, soap was added to the foam tank inlet resulting more brightness gain & stability in the system .Results are given in table 1.

## ACKNOWLEDGEMENT:

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