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# LEARNING FROM DATA – SUSTAINABLE PLANT OPTIMIZATION AT DIP 4 HOLMEN PAPER , MADRID

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## Abstract :

*Holmen Paper, Madrid recycles about 1800 tons of waste paper per day to produce high quality LWC as well as Newsprint paper.*

*The new DIP4 was started up in 2005 and recovers up to 1200 bdt/d waste paper – mainly household collection – to supply PM62 with de-inked pulp.The newsprint machine produces top of the line Newsprint grade with very stable brightness and ash parameters. With deterio-rating quality in recycled waste paper over the recent times, mill faces tough challenges in maintaining the quality parameters at constant and stable levels as before, and as demanded by the market*

*Holmen Paper therefore approached Automation X to help them mitigate the issues faced and bring back the plant performance to earlier levels in terms of both quality and efficiency.*

*The initial targets given to AutomationX was to improve yield, reduce losses and chemical consumption. The tangible benefits expected by Holmen was stability in ash and brightness parameters.*

*The first exercise was to collect their existing operating data and take it to the analytical table. Based on this raw data, modelling phase for the process steps drum pulping, flotation and bleaching was started. The result the output of phase 1 was put into practice in July 2013 using an online control – eDIP- covering the drum pulp, pre- and post flotation as well as the bleaching.*

*Even though the times were tough – market driven stand stills, challenging economic envi-ronment – the project progress was satisfying and the guarantee runs for the eDIP were started just 5 months after the project start! AutomationX established the achievement of, brightness stability and ash increased by about 30% in relative terms as well as the yield was significantly improved , translating into an increase of the production by about 10%.*

*The total cost for the project paid back within months – even including some new measure-ments, software and service for the eDIP as well as the internal effort.*

*This paper in detail discusses the methodology, information about data analyses method, the technical preconditions, the daily work with eDIP as well as the results – savings and quality benefits*


## INTRODUCTION

Holmen Paper Madrid (HPM) established in 2005 the production line PM62, a 100% recov-ered paper newsprint production with raw material from Deinking pulp plant 4 .The maximum production rate of the Deinking plant is 970 BDt/day and it is designed for an average Ash contends of 12% and a final DIP brightness of 62°. (Figure 1 – Design specifications)

For further improvement and to act on changing recovered paper qualities a new project has been developed since at DIP 4 – the implementation of a Model Predictive Control system (MPC) supplied by the AutomationX process optimization.

| | |
|---|---|
| - Start Up: | 2005 |
| - Main suppliers: | Voith, Andritz, GLV |
| - Maximum capacity: | 970 BDt/24h |
| - Range capacity: 55–100% | |
| - Efficiency: | 95 % |
| - Ash content: | 12% |
| - Brightness: | 62°ISO |
| - Yield: | 1.28 t RCP/t paper |
| - Dirt speck reduction | 95% (2500 → 125 mm²/m²) |
| - Stickies reduction | 95% (3000 → 150 mm/kg) |
| - Feed: | 16% Newspaper<br>16% Magazine<br>68% Mix |

**Figure 1 – Design Specification**

The System was implemented in August 2013. The system performance has been evaluated each month. Results from September 2013 until January 2014 have been really satisfying, achieving the two main targets of the project every month:

1- Increase the stability on DIP 4 process
2- Decrease the operational cost on DIP4

The main improvements achieved with the new system are listed as below:

- The system is all the time focused on quality parameters and it improves the stability of the process, which definitively improves the operational costs
- All the shifts work with the same strategy
- Better process knowledge. It allows us to have the process under control
- The operators have more time to focus on other issues.

The use of the system has meant savings higher than 1 € /ton during all the period analyzed, which was the project target. That is why the system can be considered a very good tool for the process optimization and could be considered to improve other lines.

## 2 Initial conditions

DIP lines in HPM are today exposed to big variations in the type and quality of the waste paper used as raw material. As a result, Operators have to be constantly vigilant and con-tinuously adjusting the process parameters manually in order to try to compensate such variations and have a stable output.

The DIP process runs through a lot of "control variables" that must be kept under control through adjustment of the so called "manipulated variables". However, this is usually a quite complex process because for these factors are inter-related and adjustment of one control variable would lead to readjustment of the related one or many other "manipulated variables" and vice versa. In other words, DIP process is a multivariable process with complex links be-tween the different variables and it is usually not easy to understand all the relations among those variables for the operators.

The onus is to find an optimal solution to make these adjustments without affecting either the quality or the cost of production. For instance, to reach the brightness goal in the final pulp one possibility is to reject more in the deinking flotation at the cost of decreasing yield in the process (higher cost) and decreasing bleaching (lower cost) or do the opposite, rejecting less in the deinking flotation, increasing yield (lower cost) but then bleaching more later to reach the brightness goal (higher cost).

It is evident that making such adjustments manually with varying quality of the incoming waste paper raw material can have a lot of limitations. Operator dependent manual adjust-ments are never consistent nor cost effective. Operator will choose what is the easiest solu-tion that need not really be the best or cost effective one, as he always has the raw material to blame, in the event of off quality product.

This is where technology steps in and helps the operator to make the right choice and the best solution. The philosophy is based on a Predictive Control System. This system can be connected to the DIP DCS to read at real time a list of selected process parameters and sends back recommended set point for some of the manipulated variables. The system uses multivariable algorithms to fulfil process goals with minimum variability at lowest cost.

Hence, it was decided to implement the "predictive control system" at DIP 4, in order to im-prove the stability in final pulp parameters (ash content and brightness) and reduce the costs by less black dye addition to keep constant the brightness in PM62. The other benefits ac-crued were in terms of reduced chemical consumption viz, less Calcium Carbonate addition on the machine, and less bleaching agent on DIP 4. The icing on the cake was the improve-ment in yield for the same furnish.

Targets for the system were:

- Improve the stability on DIP 4 final pulp (reduce the standard deviation in ash and brightness pulp more than 35% from reference period)
- Savings in the operational costs higher than 1 €/ton

## 3 Development

The project outline is displayed in Figure 2 – Project Time Line. The project was executed on time in line with the project outline. The team for this project comprised of technocrats from AutomationX and a multidisciplinary team of HPM's own in-house team namely, process en-gineers, instrumentation technician, automation engineer and a development engineer to

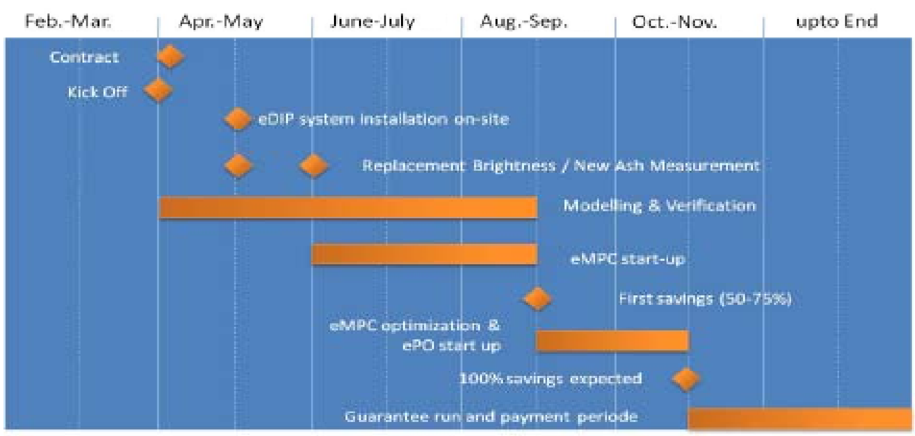



**Figure 2 – Project Time Line**

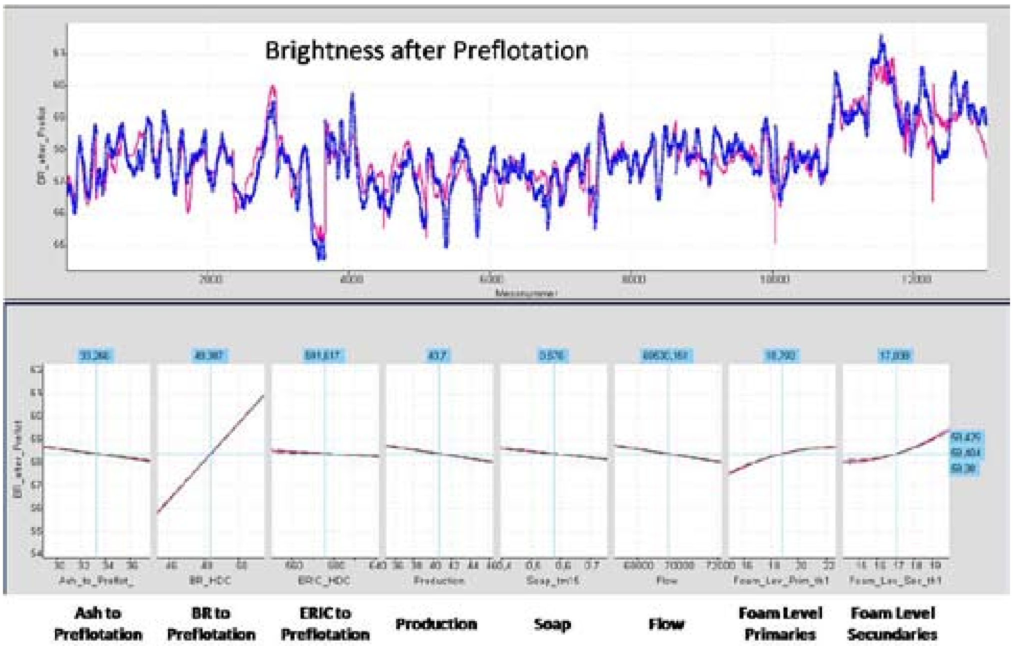
ensure the project success some small investments and the following modifications were recommended by AutomationX and implemented by the mill

- Shifting brightness transmitter from the bleaching tower to the medium consistency pump 3.
- Install a new ash sensor inlet pre-flotation
- Voluminous data collection to make the initial analysis.

The analysis allowed us to observe the potential of the system and after defining the guaran-tees the project started up.The first step was to pick up more process data to create the models to predict the process behaviour. After taking the data, AutomationX prepared a sta-tistic analysis through a software statistic tool. The main variables that the system should take into account to control the process were defined as the key parameters. Also, the control variables, manipulated variables and feed forward variables were defined.

As an example Figure 3 displays the first model for the brightness after pre flotation. The prediction is shown in blue and the real value for this control parameter is shown in pink. On the bottom part we can see the impact of different process variables on that control variable (Brightness after pre flotation).

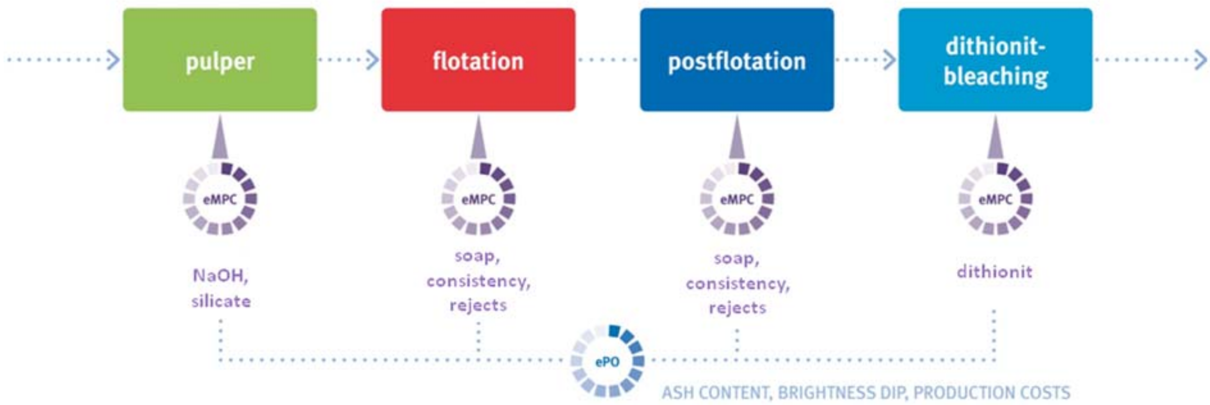
**Figure 3 – Brightness model**




The predictive control system is made up of 4 modules to describe the four main parts on the deinking process (pulping, flotation 1, flotation 2 and bleaching) and finally a superior control-ler to lead the process strategy called ePO (process optimizer).

In Figure 4 the technical concept, especially the distribution of the 4 modules and the ePO on the DIP4 line is seen.

**Figure 4 – Technical concept**



Before and during the start up of each module, there were several training sessions for the operators, to be familiar with the new screen (for example Figure 5) in the control room and the way to use the new tool. The main control buttons for start up and shut down the MPC-control, as well as the main status indications were implemented in the established DCS-System. For routine operations, the operator doesn't have to use second software.

**Figure 5 – Solution Details**

By end of July the four modules were implemented on the process, and the verification period, limits definition for the system operation and criteria to switch off the system started. It meant some changes in the models to adopt the best suited models which describe the process better, and called for some adjustments on some plant PID´s. Since August the process has been controlled by these four system modules and during September the EPO Optimizer was included, after putting in the system the different cost weights.

The EPO optimizer sends the modules the best set point for the manipulated variables at every moment, to optimize the deinking process costs. At the same time, it tries to keep the two main control variables (final brightness and ash in the pulp) as stable as possible. It was important to adjust well the balance between the two control variables (brightness and ash), because it is always a compromise.

After system verification and optimization, the guarantee run period started in October. The savings in variable cost have been measured monthly since October and compared with a reference period (before system start-up May 09–July09).

Each month has confirmed the good behaviour of the system, achieving the targets of stabil-ity and savings. Only in December the variability was higher but it was also due to important changes in raw material, and other abnormal circumstances not related to the system.

## 4 Analysis results

The results of the system use have been analyzed every month comparing them with a reference period, considering the following items from the process and variable cost:

1. Standard deviation in control variables (final pulp ash and brightness)
2. Chemical consumption and costs in DIP4 and Calcium carbonate and black dye in PM62.
3. Recovered paper use and sludge generation (Yield)
4. System time in use

The criteria for the results analysis was:

**a) Reference period data:**

- From May to July: Average in months before system installation
- Filter criteria for standard deviation calculation: only standard paper grade .01 (58.5 % ISO), production ratio higher than 36 Bdt/h, valid brightness meas-urements, no recirculation.

**b) Predictive control system (MPC) dataData from each month with the MPC switched on since September**

- Filter criteria for standard deviation calculation: only standard paper grade .01 (58.5 % ISO), production ratio higher than 36 Bdt/h, valid brightness meas-urements, no recirculation.

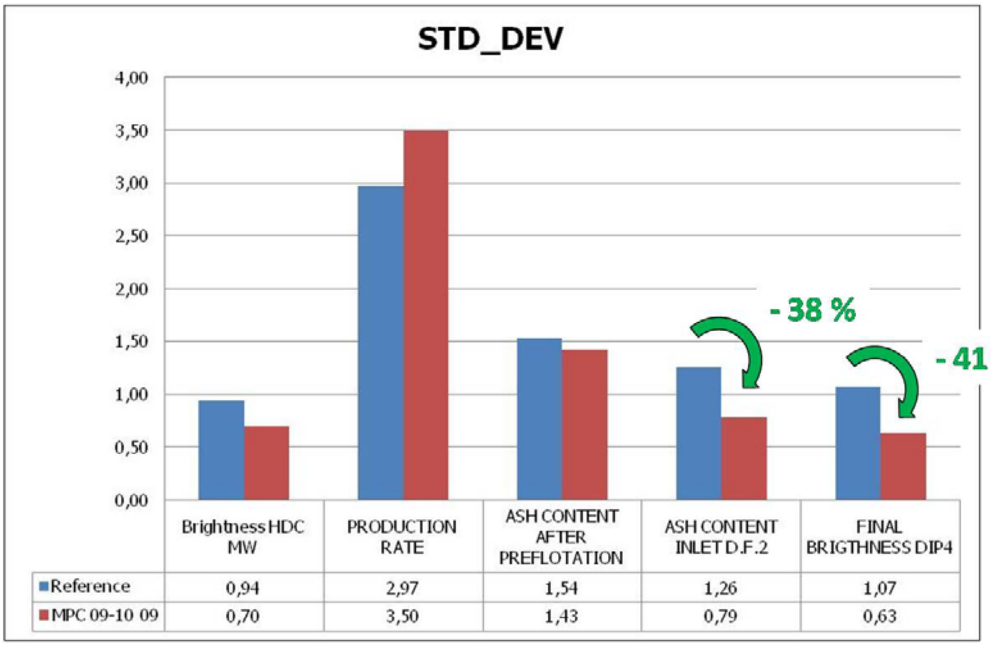
To avoid wrong values the following filters for the data analysis were taken:

| Filter conditions | DIP4 Brightness HDC cleaners | Dip 4 production ratio | Ash after preflotation | Ash after disk filter 2 | Final Brightness Dip 4 |
|---|---|---|---|---|---|
| Filter low | 45% ISO | 36 BDT/H | 14% | 10% | 55 % ISO |
| Filter high | 55% ISO | 55 BDT/H | | | |

## 1. Standard deviation in control variables:

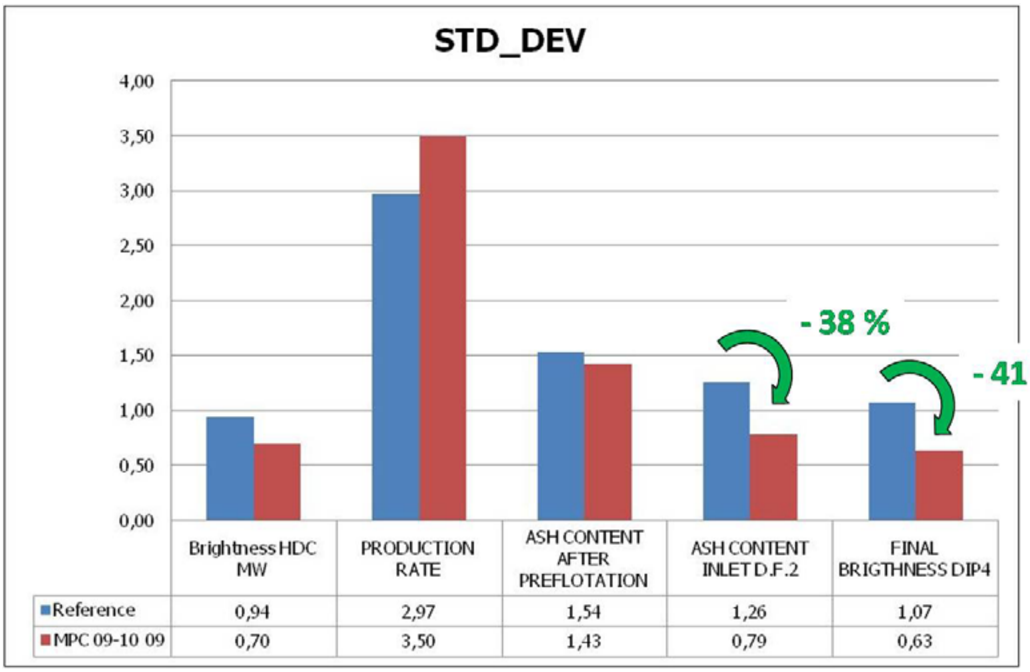
The project goal of 30% standard deviation reduction for Ash content and Final Brightness during MPC control (red bar) compared to the reference period (blue bar) was achieved.

**Figure 6 – Improvement Standard deviation**




Even due to the changes (Figure 7) of the absolute production values “production rate” – plus 7,3% - and “Ash content DIP” – plus 13,5% - and a negative impact of superior quality raw material available in December which made us to be over the target and increases the stan-dard deviation related with the set point. To avoid a situation that a quality that is “above specification” is produced, which translates to superfluous costs, an additional information system for the feeding operators in the recovered paper warehouse was also incorporated. This takes care of the operational stability when the incoming quality is superior than the normal average.

**Figure 7 – Changed production values**



## 2. Consumptions and cost

The reduction of quality variances Dip has a very positive impact on process engineer's daily work independent of DIP or PM department. But the main target was to reduce consumptions and costs. Following figures display with the red bar on the left the reference value (100%), the monthly result (blue bars) and the average improvement during AutomationX period con-trol with the red bar on the right side.  The first and main angle for cost reduction is recovered paper consumption vs. produced gross ton paper. Despite the influence of moisture on yield calculations, a monthly evaluation showed only positive impact

**Figure 8 – Recovered paper consumption**

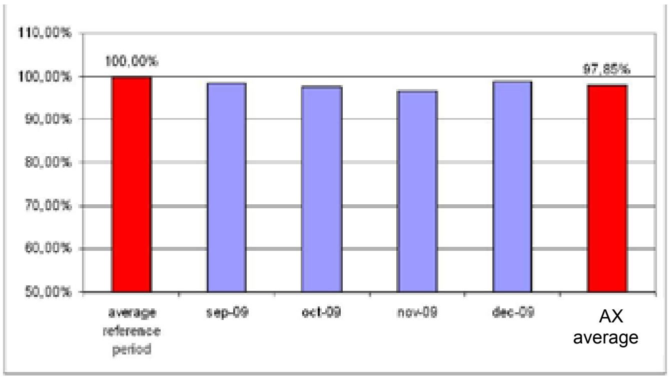
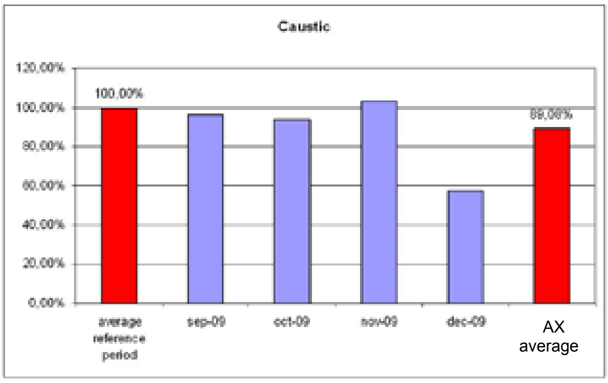



**Figure 9 – Caustic to drum pulper**




Also in the case of consumption of other chemicals and additives a positive impact was ob-served:

**Figure 10 – Silicate to drum pulper**

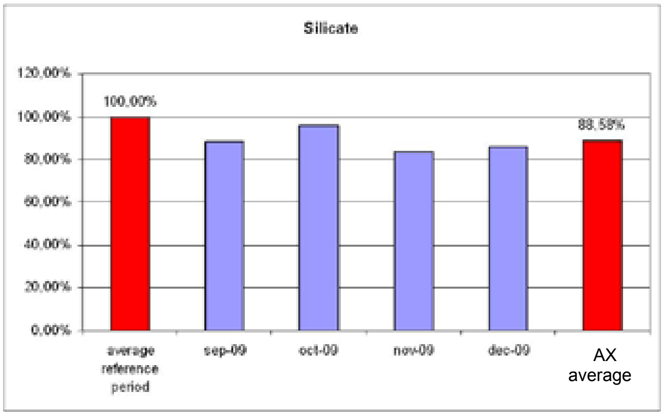



**Figure 11 – Soap to flotation cells**

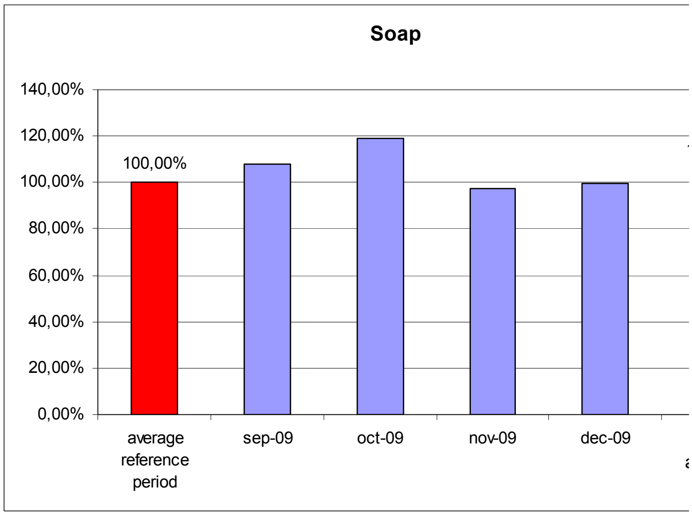



**Figure 12 – Polymers to sludge press**

On the contrary, the changes in process settings also lead to higher consumption of polymers (coagulants). Due to the higher fibre and ash yield, for a good dewatering we add manual more polymers to the sludge presses than before. However the over-all impact on chemical costs was negligible

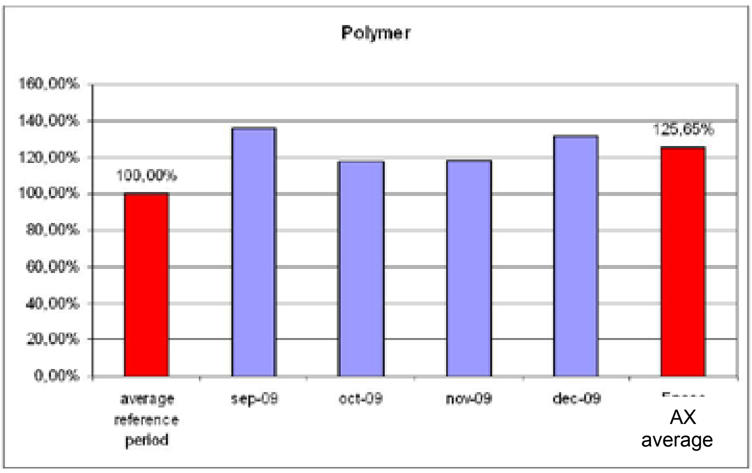
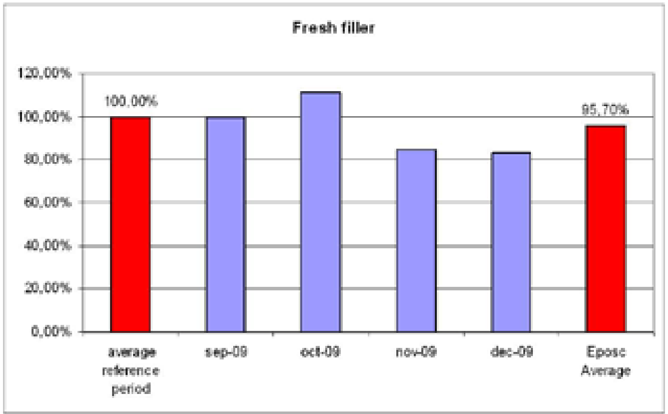



**Figure 12 – Polymers to sludge press**

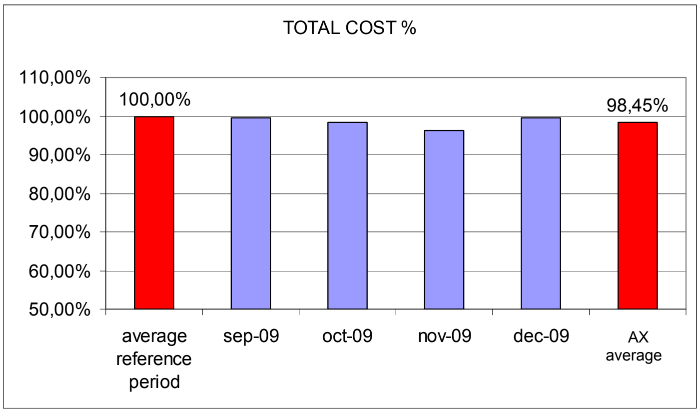
The benefits were also measurable at the paper machine. For example, the fresh filler con-sumption was reduced, despite an increase of 1.5% in the percentage of ash in final paper after the reference period.

**Figure 13 – Fresh Filler before paper machine**




Finally, attributing to the successful implementation of this project, the average production cost could be decreased and we could achieve especially succeed also the commercial tar-gets of the project.

**Figure 14 – Fresh Filler before paper machine**




## 4. Conclusion

The predictive control system by AutomationX has given thus, significant improvement on DIP 4 operations. The plant is clearly more under control; the process can automatically anticipate changes from the beginning and react by acting to compensate these changes. This way the process is automatically configured towards achieving a more stable product in DIP 4. Eventually the benefits are also accrued in the PM62, because the stability of the fibre line operations improved machine runnability. . Better ash control allows us to cary more ash along with the DIP pulp, improving the yield and reducing the fresh filler make up, added in PM62.

The only drawback of the system is when there is significant changes in the conditions of raw material, or type/grade used or in the process chemistry. Such variations will call for rebuild of the models for the system to adapt them to the new conditions if changes are too big.

To conclude, the predictive control system of AutomationX is a very good complementary tool for deinking lines and establish best practices by mills using user friendly technology that can be incorporated into any existing mill control systems.