Desolventising toaster optimisation in Solvent extraction plants (dtMAC)

About the Company -

Forbes Marshall helps build and sustain highly efficient plants by reducing waste, optimising process, and energy efficiency, and by complying with regulatory requirements.

Forbes Marshall is a leading provider of energy and process automation solutions worldwide through innovative and differentiated offerings.

Introduction –

The solvent extraction plants are used where oil is extracted from oil seeds like soybean, sunflower, cottonseed, other oil seeds and oil cakes like mustard cake, groundnut cake and rice bran.There are many sub processes in the oil making, one of them in Desolventising & toasting of the crushed seeds, Desolventizing takes place industrially in a large and complex piece of equipment called Desolventizer-Toaster, which uses steam to strip the solvent adsorbed on the solid matrix and absorbed into the oil.

Typical Construction of Desolventising toaster –

- 6-7 compartments, fitted with stirrer at centre shaft.
- Indirect steam to all compartment @7 to 8 bar (g).
- Direct steam injection in bottom 2-3 compartment.
- Contribute to around 45% of total steam consumption in the plant (Desolventising Toaster is highest steam consumer in Solvent Extraction Plants).

Problems faced by the customer in operating DT -

- Profit margins in stress because of lower crop (raw material) but higher plant installed capacity.
- Variation in raw material quality (Oil content, Inlet moisture) leading to varying product quality.
- Variations due to manual operation.
- Productivity during peak season.
- Rising cost of fuel.
- Capacity utilisation.

- Price realization of Deoiled cake ((DOC) on account of quality (moisture, Oil content, Hexane Content, colour).
- Oil carry over.
- Price realization because of Oil quality (Colour).
- High energy consumption.

The energy saving product name is dtMAC - where DT symbolizes to Desolventising toasters in solvent extraction plant (SEP), & MAC symbolizes to Measurement, Analyse, and Control.

dtMAC optimises the quality parameters for the crushed seeds which is called as deoiled cake (DOC) which comes out of dt also it ensures maximum recovery of hexane from the meal at lowest steam energy being supplied.

It is basically the complete control solution which compromises of valves, traps, sensors, PLCs & an optimised, intelligent algorithm which evaluates & sets own set point in near real time.

The innovation –

DtMAC - The innovation is in the control strategy which is basically a Machine Learning based auto tuning and auto correcting control system, which dynamically calculates its set points catering to variations in inlet process parameters and thus guarantees optimization in energy consumption, consistency in outlet product and maximum productivity.

dtMAC is well capable of handling any process parameter variation like inlet flow of meal to the dt, moisture variation in the meal, residual oil % in the meal, type of seed used & variation in it, and it optimises the DOC moisture, temperature, hexane recovery, energy required for the process in DT.

The control strategies available in the market are with fixed set point based, where operator has to change the set point based on any variation at the input, also those set points will be based on operators experience & comfort level.

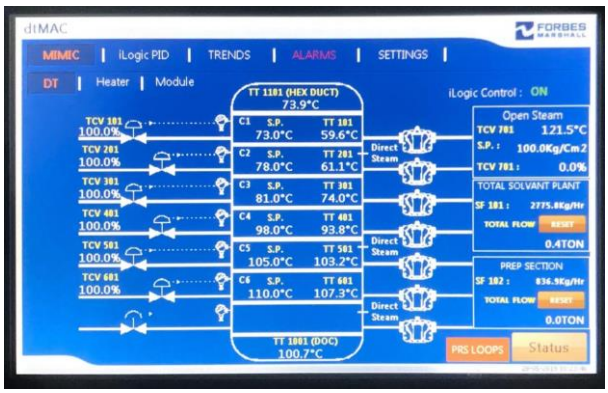
This strategy not only completely automatic and self-learning but also has capacity of taking in all process parameters calculate the most optimum region to operate, then issue new set points for control system and operate by same logic. The percentage of savings which we have achieved points towards the same.

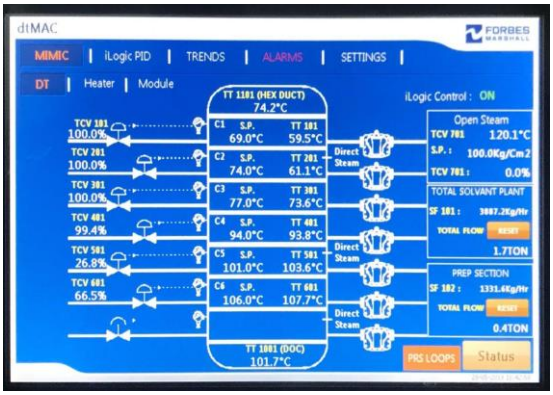
The critical parameters of Deoiled Cake (output material at Desolventising Toaster) are also seen to have tight control on variations, due to which there is higher price realization for DOC, which is also documented.

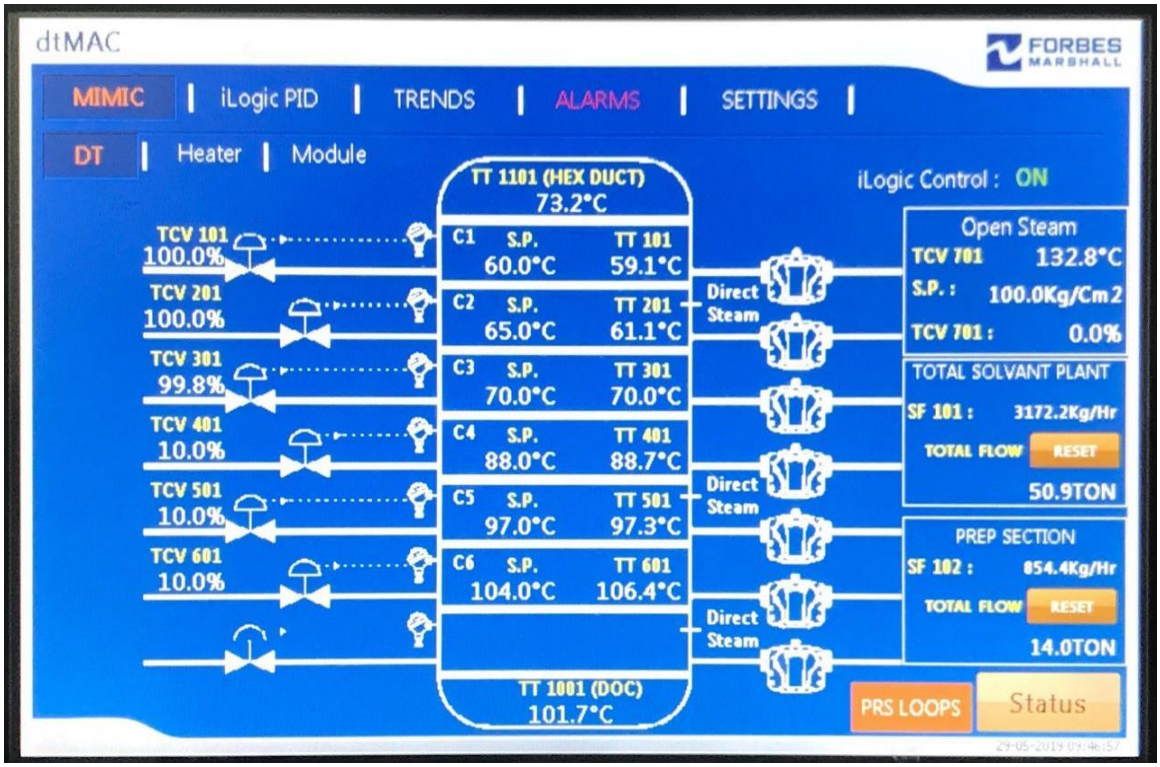
Savings of 18 to 25 % in steam consumption are documented, which have substantial impact in the annual fuel bill. For a typical 400TPD plant, savings from 35 to 40 LPA are documented.

Demonstration –

Look at the screens below where dtMAC is in operation at a plant in west Bengal, where we can clearly see that the set point is varying as per the input parameters variation, also the temperature of the compartment & its % opening is also varying.







The steam consumption for the equipment like DT or plant is measured in terms of Specific steam consumption (SSC) which is the ratio of steam consumed per kg or tonn of material processed.

In Manual operation it is documented that the SSC was around 385 kg/kg of seed material processed, it will be on slightly higher side since manual control will have human errors, variability due to operator & shift change, material change for processing etc. The process can be optimised which is evident from the higher DOC temperature.

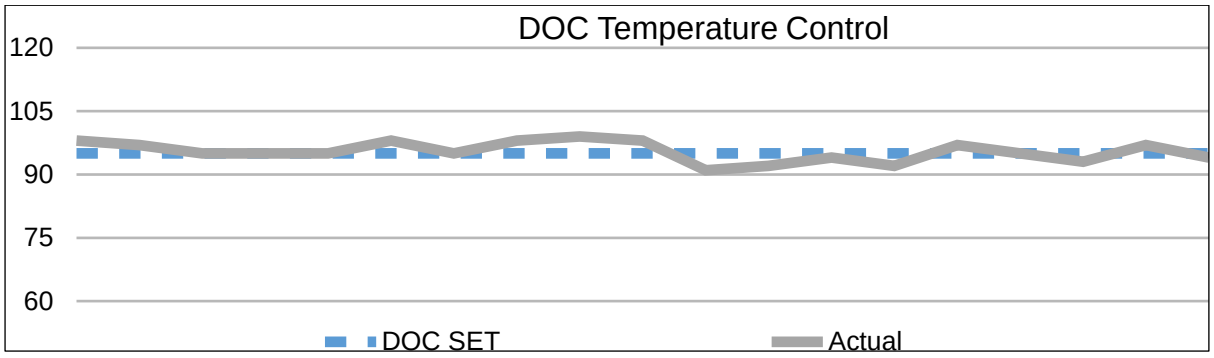
The system is put into complete automatic mode but temperature-based control system and there is definite reduction in steam consumption & DOC temperature has also reduced which can be seen through below comparison table, but still there are challenges in this control system as below,

1) Set point is decided by the experience of the operator
2) If set point is not changed then system performance is not optimised
3) There are customers which will frequently changes the input material for the processing & thus set points need to be changed frequently

4) There is no feedback or self-correction from the system

Looking at the above bottlenecks the fully automated system is made intelligent by adding the Machine learning (ML) based self-learning & self-correcting algorithm & results shows savings based on top of the fully automated system, can be seen from below table of comparison, also it ensures the consistency on the DOC quality which means higher price realisation for selling of DOC as animal feed.

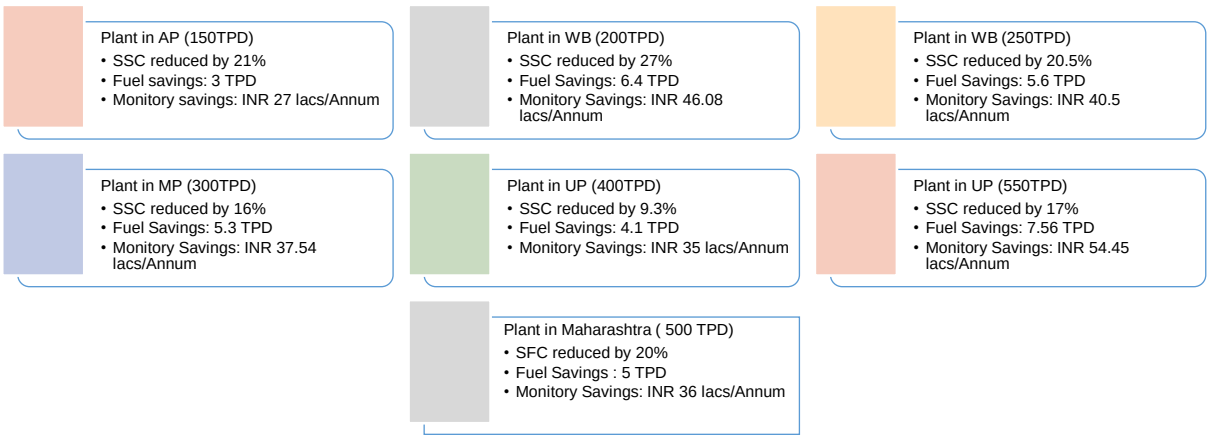
	Manual Operation	Auto Operation	Intelligent Operation
Chamber 1		80 deg c	75 deg c
Chamber 2		85 deg c	80 deg c
Chamber 3		85 deg c	85 deg c
Chamber 4		90 deg c	85 deg c
Chamber 5		95 deg c	90 deg c
Chamber 6		100 deg c	95 deg c
Chamber 7		105 deg c	95 deg c
DOC Temperature	**102 to 108 deg c**	**99 to 103 deg c**	**94 to 97 deg c**
SSC	**385 kg/kg**	**345 kg/kg**	**305 kg/kg**



Results –

As seen clearly from the above table of comparison, we can save 20% of steam with ML based algorithm system than that of manually operated system & can save around 9% of steam than fully automated temp. Control based system.

Please find the snapshots of the results received from the system from different plants in India. Results are self-explanatory as well as very consistent through a period of time.



Note: Fuel considered – Rice husk, GCV-3200, Fuel cost Rs. 3/kg, Days of operation varying from 240 to 300 days/annum.

Opportunity in India –

- Solvent Extraction Plants with reasonable capacity in India are around 500 in numbers of variable capacities from 100 to 1000 TPD.
- Energy reductions possible 20% through the solution discussed.
  - Fuel savings of 4.85 TPD for average 300 TPD plant and 200 days of operation plant leading to savings of 4,85,000 tons of fuel.
  - Steam Savings of 14,55,000 tons which is 70,56,75,000 kcal of energy.
- Monitory Savings of Rs.1,45.5 Crores which is Rs. 29 Lacs per plant.
- Potential mapped can be extrapolated worldwide where India's edible oil contribution to world is 3-5%.