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White paper on the FMCG - edible oils and soaps segment

A. Critical segmentation of the industry – operational controls and quality differentiation in the product engineering initiatives

1. Refining and distillation – the fundamentals

1.1. **Enthalpy in composite fluid systems:** Multiple components in the crude palm oil composite that need separation and the fundamental separation rallies around the fluid properties of built up pressure in the fluid systems and the total heat in the system. The enthalpy of the fluid system is determined by the dynamic flow rates, the pressure differential built up in the flow path, the specific gravities of the fluids and the changes registered in the values of the specific gravity with the progressive refining or distillation processes and finally the concentrates of static charges on the structural changes in the chemical makeover that do occur in the refining process.

In the accompanying illustration, the impact of fluid temperature on the viscosity is clarified for a range of fluids and these differences in intrinsic viscosity establish the foundation for the refining process to happen effectively.

Consequently the enthalpy in the fluid composite is the singularly important variable in the process and needs a detailed treatment. The fluid properties influencing the quantum of internal enthalpy in a give fluid and the systemic enthalpy as defined in the composite are fundamentally different and progressively diverge on the up end of the refining process. The internal enthalpy is definitive of the following influences:

a) The specific gravity of the fluid is the key determinant. Generic influences suggest a direct relationship between the specific gravity, the natural viscosity of the fluid and the enthalpy levels in the system. Also, the structural strength of the chemical bonds in the fluid define the endothermic changes in the chemistry of the oil and attribute to the sum total of potential heat in the system and consequently also the values of electrostatic potential in the static charge concentrates developing as a consequence of the degradation in the original chemical configuration.

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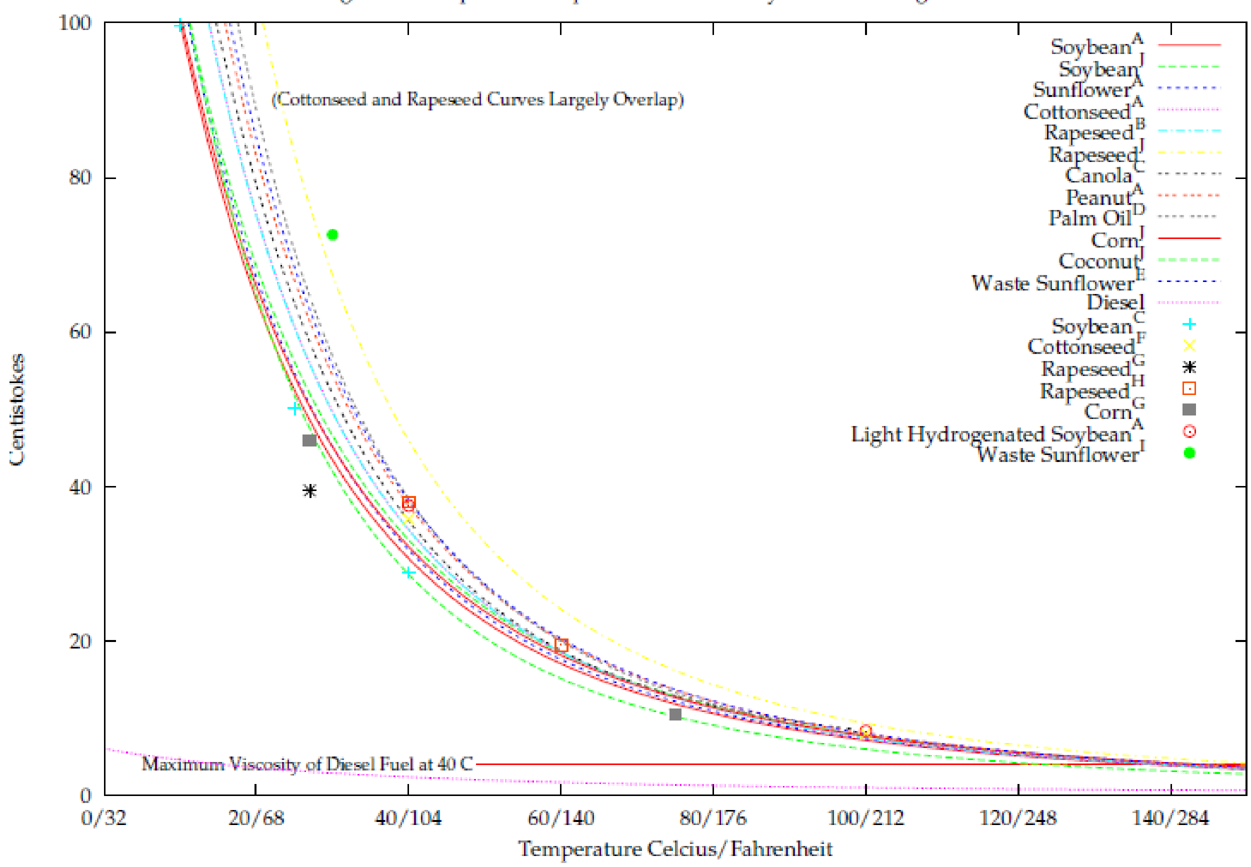
Figure A: Temperature Dependence of Viscosity of Various Vegetable Oils



b) The fluid shear resistance is another important variable in building up higher thresholds of enthalpy in the internal system and defining the refining complexity and dynamics of a given composite.

The fluid resistance to shear is an important attribute in the refining process and is a function of the following parametric variables:

b. i) The bond strength in the chemical configuration and the energy structuring the bonding of the compounds is the key determinant. The endothermic levels define the threshold of breaking away of the

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chemical structure and the entropy of the system that promotes the chemical dissipation of the bonds shall in turn determine the resistance to fluid shears across several small cross-sections within the fluid. The conditions for these changes in structural configuration are influenced by the enthalpy state changes and thresholds that bring in the excitation in the molecular levels. In that, the fluid pressure defined by the dynamic volume in the piping network that describes the transfer mechanism plays a critical role in providing the dynamic pressure and hence the desired enthalpy threshold to promote this excitation to set in and promote the ease of refining in the composite.

b. ii) The pumping dynamics is influenced by the structural construction and quantum of wear that attributes to wall friction during the flow of the fluids as also by the all-important quality of electromotive drives provided to the pumps by the motors. The kW load going into the pump drives is the effective impetus provided to the fluids and determines the forces developed within the system to overcome the frictional forces in the piping network and defining the dynamic pressure to the fluid; the key ingredient that overcomes the fluid shear and promotes the excitation in the molecular state to release the free radicals – the most important phenomenon in the refining process that shapes the quality of separation of the competing components in the oil composite.

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Pump configuration		Phase current analysis			Estimated PF analysis							Load Analysis		
Pump	Linkage	Ra	Ya	Ba	Resultant	Resolved RMS	Line Voltage	P	Q	PF	Phase angle	Rating	Load %	Phase difference
P1	Fat booster pump	6.9	7.2	7.1	12.2	11.3	415.0	5.1	4.7	0.734	83	10.0	122%	4%
P2	Condensate extraction pump	1	1	1	1.7	0.8	415.0	0.7	0.3	0.902	51	10.0	17%	0%
P3	FA transfer	11.2	11.2	11.2	19.4	23.3	415.0	8.1	9.7	0.640	96	10.0	194%	0%
PD-1A	Fat high pressure pump	26.1	26.8	25.8	45.4	31.8	415.0	18.9	13.2	0.819	69	67.0	68%	4%
P-1 SWTP	Pressure feed pump	9	9.5	9.4	16.1	16.6	415.0	6.7	6.9	0.697	89	11.0	146%	6%
V1 SWEP	Condensate extraction pump	3.6	3.3	3.6	6.1	3.8	415.0	2.5	1.6	0.845	64	12.0	51%	9%
V1 FSP	Vacuum pump evaporative	9.3	8.3	9.3	15.6	14.4	415.0	6.5	6.0	0.733	84	13.0	120%	12%

PP-2AFSP	Water high pressure pump with forced cooling fan	20.2	20.1	20.5	35.1	50.8	415.0	14.6	21.1	0.568	103	14.0	251%	2%
P6-FSP	Water booster pump	1.5	1.5	1.5	2.6	1.2	415.0	1.1	0.5	0.902	51	15.0	17%	0%
V1	Vacuum pump C1	7.6	7.8	8	13.5	10.4	415.0	5.6	4.3	0.791	74	16.0	84%	5%
V2	Vacuum pump C2	9.5	10.1	10.5	17.4	15.0	415.0	7.2	6.2	0.757	80	17.0	102%	11%
P-11	**FADP**	7.6	7.8	7.9	13.5	9.8	415.0	5.6	4.1	0.809	71	18.0	75%	4%
P3 FSP	**FADP**	1.5	1.5	1.5	2.6	1.2	415.0	1.1	0.5	0.907	50	19.0	14%	0%
GD-5	First grade glycerine pump	5.9	6	6	10.3	6.4	415.0	4.3	2.7	0.849	63	20.0	52%	2%
P 10	FADP scrubber pump	5.9	5.6	5.8	10.0	6.2	415.0	4.1	2.6	0.851	63	21.0	48%	5%

b. iii) The sensible heat in the fluid system is the equilibrium achieved in the medium having the competing components of the parent fluids and requires a fundamental exchange commensurate with the chemical structure of the individual composite components but in reality the external influences of the relative states of the piping network and the flow pressure as explained above determine the real exchange of heat beating the predictions of the structural configuration in the chemical realm and hence distort the natural chemistry of changes in the refining process thereby delaying the rate of degradation and separation through free radical exchanges. This distortion creates a system wherein structurally robust enthalpy states in a fluid component cause a greater resistance to change through higher fluid shears and vice-versa thereby promoting the wearing off of structurally weak components at a faster rate than is advisable from a quality perspective. The resultant of all of these fundamental distortions in the natural chemical configuration and shear differential is the creation of varying levels of refining states in the process that are fundamentally incongruent with the natural chemistry and hence affects the quality adversely. This is the root cause of issues related to refining quality and the resultant needs for high costs of cyclic refining solutions for upgrading the quality to desired levels.

Pump configuration	
Pump	Stage
P332 B	Cooling tower pump
P 331 A	Chilled water pump
P 311	Crystallizer pump
P 312	
P 314	
P 514	RBD storage tank
P 512	Olein storage tank
P 513	Steam storage tank
P303	Cooling tower fan

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Stage			
Cooling tower pump			
Chilled water pump			
Crystallizer pump			
RBD storage tank			
Olein storage tank			
Steam storage tank			
Cooling tower fan			
Pump characteristics			
Head	Flow rate	Shaft temperature	Motor shaft
35	160	35	39
56	60	37	42
30	50	38	41
30	50	35	38
30	50	45	37
		47	43
		42	41
		38	35
		37	42

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Heat Conservation factors						
Input temperature	Vessel Temperature	Output temperature		Specific Gravity	pH	Temperature of material
72	110	77	67.73%	9.0%	9.1	110
45	70	52	69.29%	5.0%	9.4	75
75	118	72	62.29%	6.0%	8.3	115

Color Chemistry			
Rc = Red color co-ordinates	Yc = Yellow Color Co-ordinates	Bc= Blue Color co-ordinates	RRc = Resultant color co-ordinates
4.2	2.8	3.2	2.33
3.8	2.9	3.3	2.31
4.1	3.7	2.9	2.75

c) The differential between the flash points of the competing components in the composite is the last in the series of important variables that define the refining process in the crude palm oil industry but is often ignored. The structural configuration and the bond strengths therein determine the eventual flash points that can change the viscosity irreversibly and fundamentally differ from each other although on a narrow bandwidth. This is an important variable that defines the ease of refining in the process. Composites having components that varies widely in terms of flash point attributes are relatively easy to refine and the complexity increases at points wherein the variations narrow down to negligible levels since the differentiating features that aid and accelerate the refining do boil down to pressure differentials and differences in fluid shear and the sensible heat differences at the surface causing the surface tension differential in the first place. The crude palm oil (CPO) industry has the biggest refining issue arising out of the fundamental nature of the components that constitute the oil composite in as much as all of these components are chemically similar and hence have very closely matching flash points; the only differences being that there are certain components that do take up a relatively higher degrees of adherence to contaminants of dust and sand and other micro particles as compared to the other competing components thereby raising the flash points effectively a shade higher than the generic value.

c. i) The surface tension differential between the competing components in an given oil composite facilitates the separation at certain harmonics of temperature; effectively there are subtle points in the temperature curve at which the surface tension differential in the oil composite facilitate the separation and at other points in the temperature curve there might be very little or negligible separation; thereby promoting the case for maintaining strong pumping dynamics and achieving consistency over timelines through the effective maintenance of the piping network and the electromotive forces going into the drives quality.

c. ii) The chemical configuration constituting the structure of the oil defines the propensity to generate the static charge concentrate on exothermic reactions accompanying the exchange of free radicals in the refining process and this fundamental concentrate defines the frictional properties of the dynamic fluid flows. These frictional differences facilitate the refining process; more pronounced the differences in the concentration, greater is the ease of separation or refining. This attribute is more pronounced if the resistance to creation of the charge concentrates is high and therefore fundamentally opaque as compared to the translucent components that have varying degrees of propensity to form charge concentrates and create the effects of dielectric medium in the fluids – the primary harbinger to effective refining.

Analysis of the distillation area ducting network				
Pump	**Temp. at pump**	**Before**	**After**	**Heat Loss%**
P9	182.4	180.7	172	97%
P10	70.6	69	65.6	95%
P5	230	225.9	222.3	97%
P1	85	84	78	95%
P2	219	210.5	209	96%
P4	190	187	185.4	98%
P3	230	224	215.1	95%
P11	115	108.3	107	94%
P7	238	230	224	95%
P8	240	235.6	235	98%

c. iii) Vessel volume and the quality of flow properties in conjunction with each other define the conditions of the dynamic pressure built into the fluid; an important determinant in evaluating the distillation quality. The fluid pressure is always a function of the flow properties of the composite and the resulting volume that defines the specific pressure built into the system and hence is a natural phenomenon that can be accurately maintained with consistency so long as the constituent properties described above are religiously maintained. Thus the fall out is fundamentally maintaining the fluid temperature – the determinant being a derivative of the compression built into the system and influences the color of the refined fluid at that stage in the process chain.

Quality derivatives of color coordinates and the percentage changes as well as the reproducibility of the definition of the coordinates between the batch runs are the important nodal points of control for the refining processes and inability in a system to monitor the trends is a process impairment that can be damaging for the quality consistency.

In the illustration above, the coordinates and the corresponding fluid temperature and the flow rates have been compared, tabulated and monitored for controls and similar controls are required for the distillation processes to be differentiated in order to make a significant impact in the eventual quality of the product.

Control points for regulating the color coordinates are:

1. Piping corrosion and the resulting increase in friction that affects the fluid flow rates in the equilibrium modes after the traction states are overcome.

2. The pumping dynamics in terms of kW extraction as is reflected by the effective PF.

3. The fluid temperature achieved through effective heat transfer at each point of the distillation process; the heat being the key determinant for the segregation of the components.

4. The cooling tower effectiveness to maintain the temperature gradient at all stages in a consistent manner.

5. The cycle timing accuracy as determined by the refining chain motor efficiency at all stages.

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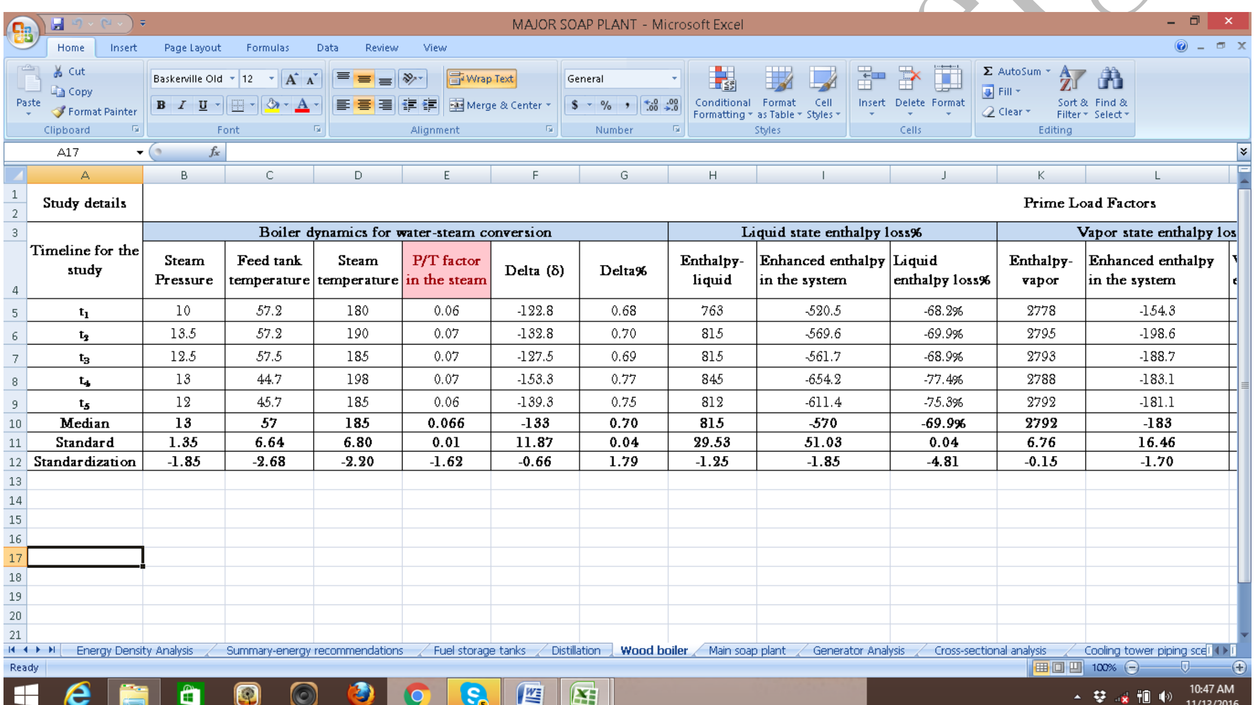
UTILITY ENGINEERING:

A.Compressor dynamics:

Compressor Load Analysis					
Study Timeline		Pressure	Operating Load %	Element Temperature	Motor Current
t_1	12:00	7.5	77	87	94
t_2	12:20	7	100	91	114.28
t_3	12:40	7.5	65	91	92.45
t_4	13:00	7	100	89	115.15
t_5	14:40	6.9	100	88	110.55
t_6	15:20	7.5	89	85	97.3
t_7	15:40	7.5	55	92	91.72
t_8	16:00	7.5	46	79	90.35
t_9	16:20	7.5	53	92	91.33
t_{10}	16:40	7.5	52	90	91.2
t_{11}	17:00	7.5	51	84	91.52
Median		**7.5**	**65**	**89**	**92.45**
Standard Deviation		**0.25**	**22.09**	**4.02**	**9.97**
Standardization		**-2.79**	**-0.45**	**-0.99**	**-0.25**

Creating the turnaround algorithm

B. Boiler dynamics:



Study details											Prime Load Factors
	Boiler dynamics for water-steam conversion						Liquid state enthalpy loss%			Vapor state enthalpy los	
Timeline for the study	Steam Pressure	Feed tank temperature	Steam temperature	P/T factor in the steam	Delta (δ)	Delta%	Enthalpy-liquid	Enhanced enthalpy in the system	Liquid enthalpy loss%	Enthalpy-vapor	Enhanced enthalpy in the system
t_1	10	57.2	180	0.06	-122.8	0.68	763	-520.5	-68.2%	2778	-154.3
t_2	13.5	57.2	190	0.07	-132.8	0.70	815	-569.6	-69.9%	2795	-198.6
t_3	12.5	57.5	185	0.07	-127.5	0.69	815	-561.7	-68.9%	2793	-188.7
t_4	13	44.7	198	0.07	-153.3	0.77	845	-654.2	-77.4%	2788	-183.1
t_5	12	45.7	185	0.06	-139.3	0.75	812	-611.4	-75.3%	2792	-181.1
Median	**13**	**57**	**185**	**0.066**	**-133**	**0.70**	**815**	**-570**	**-69.9%**	**2792**	**-183**
Standard	**1.35**	**6.64**	**6.80**	**0.01**	**11.87**	**0.04**	**29.53**	**51.03**	**0.04**	**6.76**	**16.46**
Standardization	**-1.85**	**-2.68**	**-2.20**	**-1.62**	**-0.66**	**1.79**	**-1.25**	**-1.85**	**-4.81**	**-0.15**	**-1.70**

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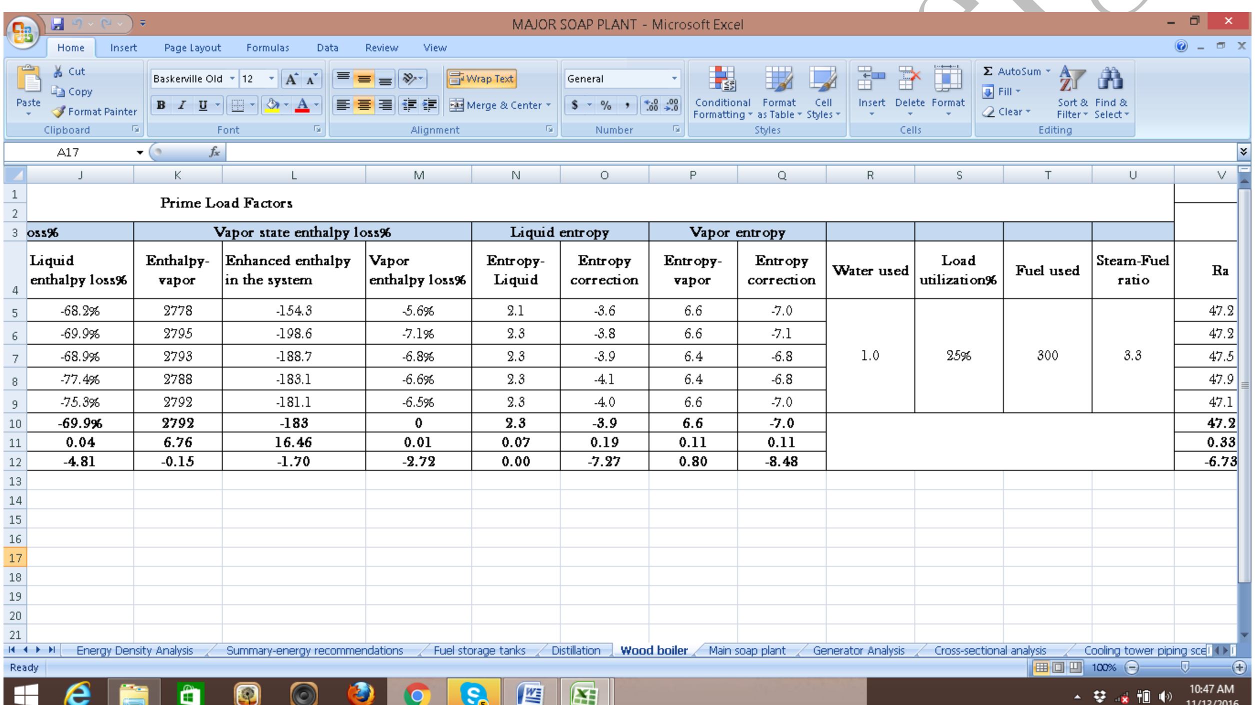

MAJOR SOAP PLANT - Microsoft Excel

Prime Load Factors

oss%	Vapor state enthalpy loss%			Liquid entropy		Vapor entropy						
Liquid enthalpy loss%	Enthalpy-vapor	Enhanced enthalpy in the system	Vapor enthalpy loss%	Entropy-Liquid	Entropy correction	Entropy-vapor	Entropy correction	Water used	Load utilization%	Fuel used	Steam-Fuel ratio	Ra
-68.2%	2778	-154.3	-5.6%	2.1	-3.6	6.6	-7.0	1.0	25%	300	3.3	47.2
-69.9%	2795	-198.6	-7.1%	2.3	-3.8	6.6	-7.1					47.2
-68.9%	2793	-188.7	-6.8%	2.3	-3.9	6.4	-6.8					47.5
-77.4%	2788	-183.1	-6.6%	2.3	-4.1	6.4	-6.8					47.9
-75.3%	2792	-181.1	-6.5%	2.3	-4.0	6.6	-7.0					47.1
-69.9%	**2792**	**-183**	**0**	**2.3**	**-3.9**	**6.6**	**-7.0**					**47.2**
0.04	**6.76**	**16.46**	**0.01**	**0.07**	**0.19**	**0.11**	**0.11**					**0.33**
-4.81	**-0.15**	**-1.70**	**-2.72**	**0.00**	**-7.27**	**0.80**	**-8.48**					**-6.73**

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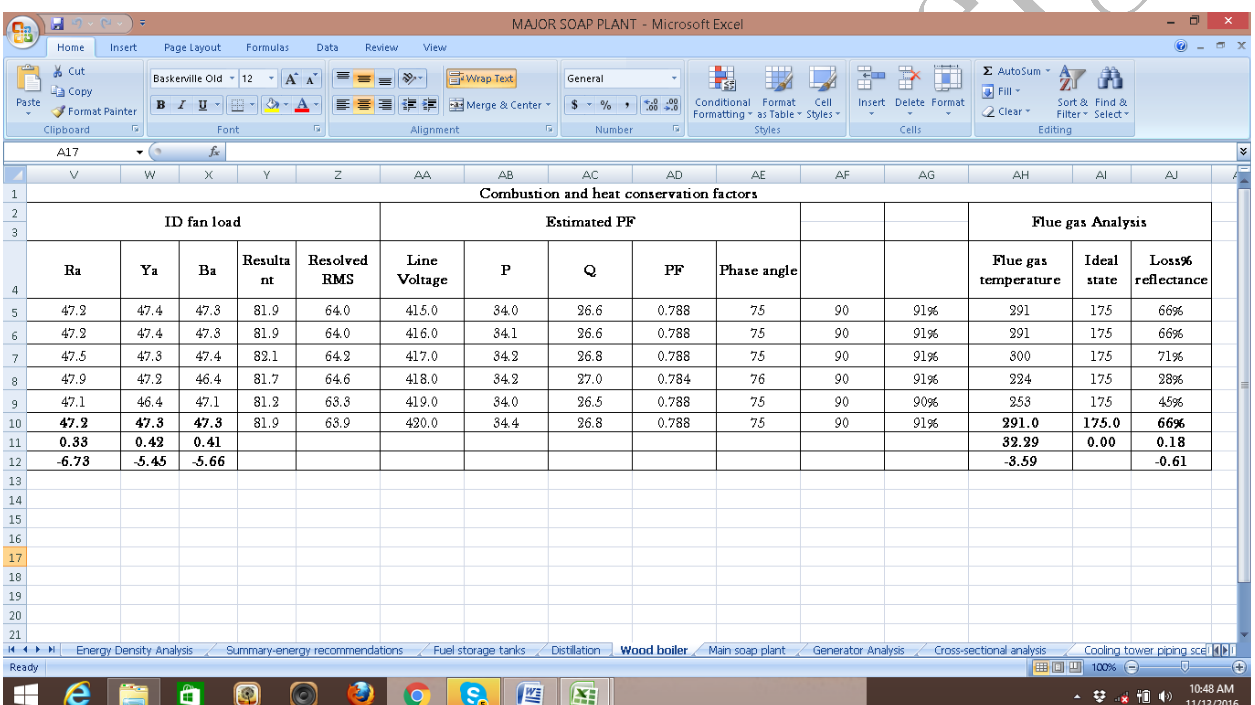

Combustion and heat conservation factors

ID fan load					Estimated PF							Flue gas Analysis		
Ra	Ya	Ba	Resultant	Resolved RMS	Line Voltage	P	Q	PF	Phase angle			Flue gas temperature	Ideal state	Loss% reflectance
47.2	47.4	47.3	81.9	64.0	415.0	34.0	26.6	0.788	75	90	91%	291	175	66%
47.2	47.4	47.3	81.9	64.0	416.0	34.1	26.6	0.788	75	90	91%	291	175	66%
47.5	47.3	47.4	82.1	64.2	417.0	34.2	26.8	0.788	75	90	91%	300	175	71%
47.9	47.2	46.4	81.7	64.6	418.0	34.2	27.0	0.784	76	90	91%	224	175	28%
47.1	46.4	47.1	81.2	63.3	419.0	34.0	26.5	0.788	75	90	90%	253	175	45%
47.2	**47.3**	**47.3**	81.9	63.9	420.0	34.4	26.8	0.788	75	90	91%	**291.0**	**175.0**	**66%**
0.33	**0.42**	**0.41**										**32.29**	**0.00**	**0.18**
-6.73	**-5.45**	**-5.66**										**-3.59**		**-0.61**

The management of the compressor and the boiler assume great significance in the distillation process and in ensuring the right fractionation – as discussed in the article and would need several parameters of performance to be looked into simultaneously as illustrated in the screen shots and the table. Sans all of these controls, the quality of distillation and refining in the edible oils and soaps factory are severely impaired.

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The industry dynamics need to change in the operating fundamentals to make a significant difference in the fortunes of the industry as part of the perpetual quest for enhancing the margins in the value chain. Sans the controls discussed at length in the article, the quality derivatives and the concomitant issues related to productivity and the consequent impact of the cost of conversion in the balance sheet cannot be realized. In the long run, the debilitating effects of the macro fundamentals shall catch up with the industry with potentially disastrous consequences.

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