

# **STRONG AND FLEXIBLE THERMAL AND ENVIRONMENTAL COUPLING BETWEEN PULP DRYING AND SUGAR PROCESS**

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## **Introduction:**

Sugar beet pulp drying is important in energy losses and environmental issues. The objective of the paper is to present through low temperature air beet dryer results and triple pass turbo dryer results obtained in large scale plants, a new combination of both technologies to reduce energy consumption as well as rise pellets quality and lower environmental impact. An original coupling of this combination with the sugar beet factory is studied in order to minimize fossil fuel consumption by enlarging low temperature air beet dryer capacity. Coupling of a low temperature air beet dryer with a beet factory has been successful in Europe to reduce drastically fossil fuel consumption. The purpose of the new combination is to reduce to minimum fossil fuel consumption, to keep actual factory energy production scheme, to reduce coupling impact on beet factory operations and so to ensure lower sugar beet plant adaptations for concept implementation. Based on both equipment obtained performances a simulation of the implemented solution on averaged 10 000 metric tons per day beet sugar factory is detailed.

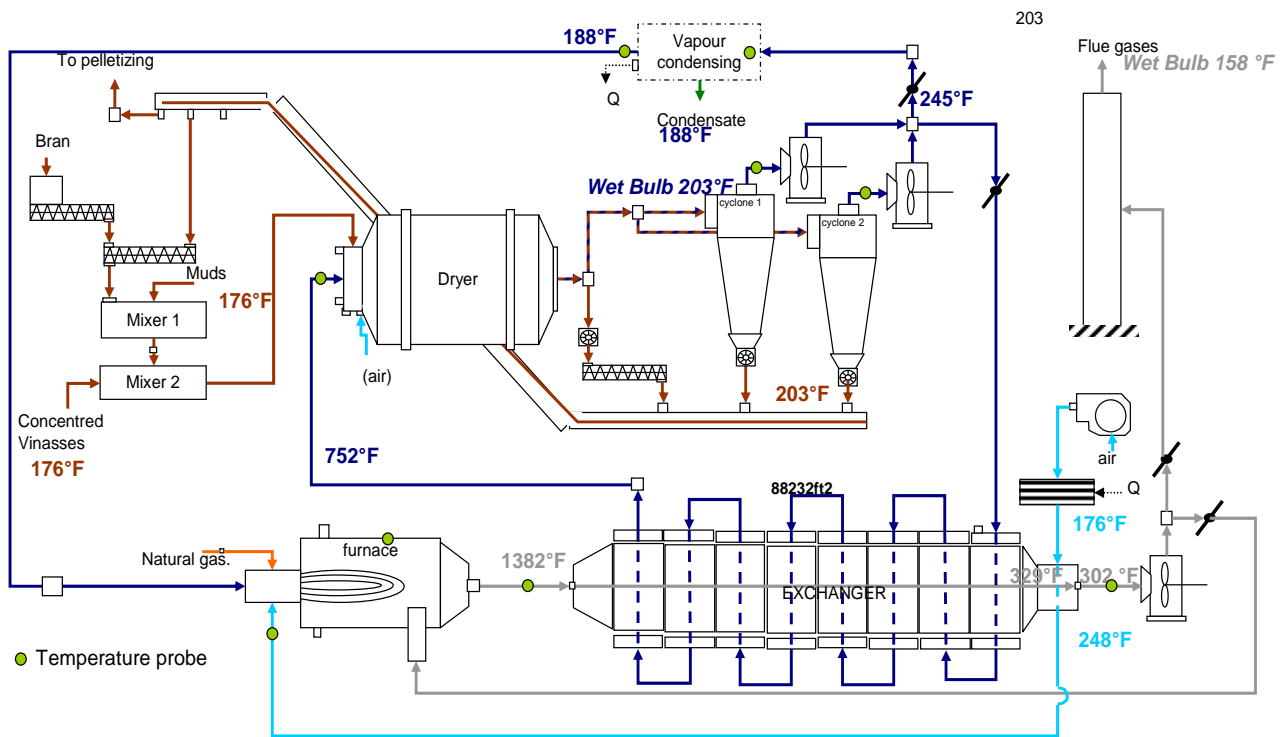
The concept isolated from sugar beet plant can reduce by factor 2 fossil fuel consumptions/costs. Coupling the concept with sugar beet plant can reduce 80 % and more fossil fuel consumptions/costs for beet drying operation considering a 242.5 U.S. gpm (32.4 ft<sup>3</sup>/min or 55m<sup>3</sup>/h) water is removed in the process to dry from 27.5 %DM (Dry Matter) to 90 %DM. Technology to ensure such strong economy with minimal impact at reasonable capital cost is described in the paper. Simulations are showing that even on a low consumption beet sugar plant the economy remains.

## **Pass Turbo Dryer:**

Vapour main stream from 3 PASS DRYER is reheated in a heat exchanger fed with flue gases produced in a furnace (any fuel can be proposed, the furnace and exchanger are designed accordingly). Vapour is heated up to 752 °F (400 °C) at atmospheric pressure and is recycled at drying drum inlet to make a quick drying. Vapour lower stream according to water evaporated from material goes to an exchanger that can be an evaporator to concentrate DS in a liquid and produce low pressure steam or a condenser to produce high stream of hot water above 194°F (90 °C). The design allows increasing water content into vapour to 7 lb/lb of dry air and more as we are at atmospheric pressure and false air is reduced to minimum. Flue gases temperature is reduced both by combustion air and dilution air. Dilution air is used to reduce flue gases temperature to heat exchanger temperature as per design. Flue gases temperature at the chimney can be reduced to 278.6°F (137 °C) when fuel is natural gas. The 3 PASS DRYER produces excess vapour from material evaporated water to be used in a second and/or third stage of concentration. In our paper we consider only that this excess vapour produce high stream of hot water trough a condenser. Water is condensed and goes to water treatment and gases are burnt into the furnace guarantying no polluted air emissions. Here after joined concept scheme and picture based on our installations.

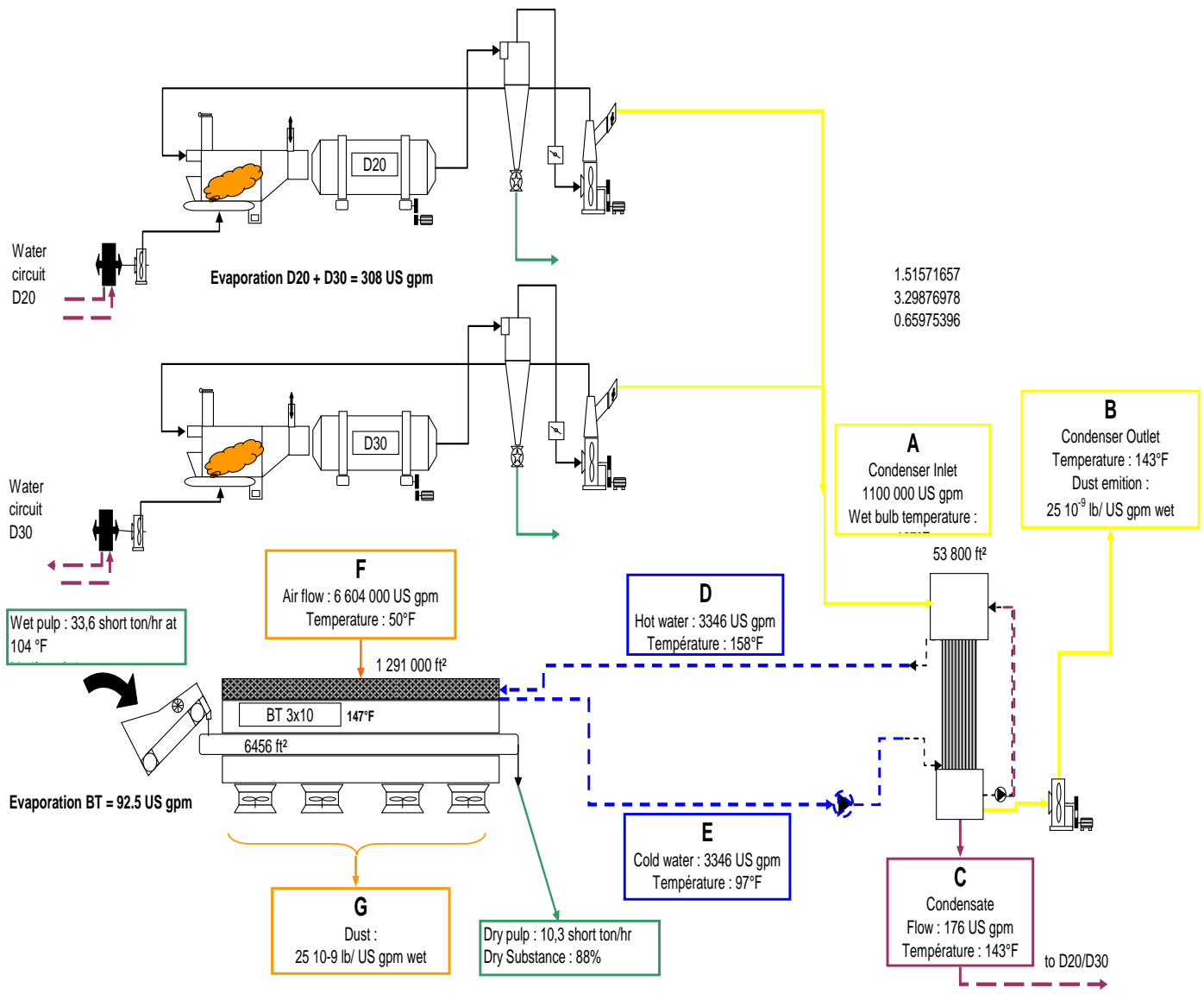


3 PASS DRYER -----Heat Exchanger-----Furnace



### **Belt Dryer:**

The BELT DRYER allows to dry beet pulp or other biomass materials with hot air. BELT DRYER can dry up to 90 % DS content beet pulp as a dryer or up to about 50 % DS content beet pulp as predryer. In points 5 and 6 we will consider BELT DRYER as predryer. When BELT DRYER is a predryer 3 PASS DRYER above described is drying remaining water in the product with higher vapour temperature from 50 % DS to 90 % DS. In the following example classical triple pass drying drums outlet vapour is condensed and is heating a hot water loop to the BELT DRYER water/air heat exchanger. That way a part of the pulps are dried at low temperature (high quality). COV are reduced. Dust emissions are reduced as hot air is passing through the product layer and drying screen.





CONDENSER



BELT DRYER

## **Pulp Pressing:**

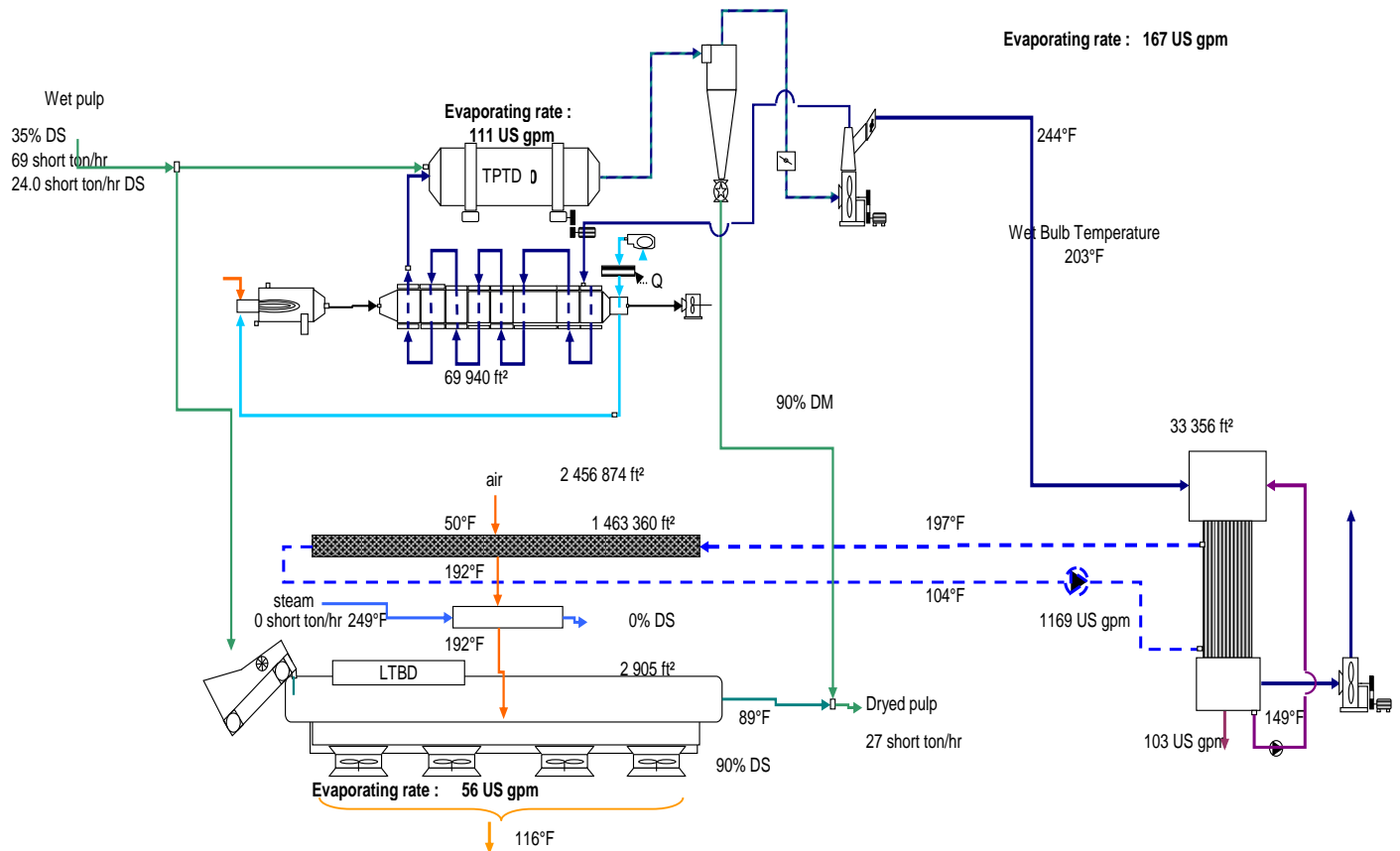
Pulp pressing becomes a major issue as fossil fuel price follows a long term increasing trend. Electrical kWh consumed to pulp dewatering is much lower compared to Thermal kWh used in the dryer. Moreover sugar recovery is still an issue. That way, we consider that in a beet pulp drying project beet pulp pressing has to be included in the global drying scheme study. More and more sites push press pulps above 30 % DS. Twin screw press technology allows with strengthened reducers and spindles to target 35 % DS. R&D program are in progress to develop technology to obtain above 40 % DS. In our paper we consider that pulp pressing is increased from 27.5 % to 35 % DS based on our pulp press designer experience. With 19.8 short tons/h, (21.8 metric t/h) of dry matter in pulp then pulp pressing is dewatering an additional 74.8 us gpm (10 ft<sup>3</sup>/min, 17 m<sup>3</sup>/h). Moreover, as an example if we consider 1.6 % of sucrose in press water then an additional 710 short tons (783 metric tons) of sucrose are extracted per 120 days campaign. As usually press water must be properly filtered to remove pulp fines before diffuser. With standard beet quality we can consider that electrical consumed power increase from 2.46MMBtu/hr (720 kW) at 27.5% DM up to 3.63MMBtu/hr (1064 kW) at 35 % DM rising specific power consumption from 18089 Btu (5.3 kWh) to 23891 Btu (7 kWh) per metric ton of press water produced. Then the additional 74.8 US gpm of press water requires 0.406 MMBtu (119 kWh) that is much lower compared to thermal consumption in drying process. For a new press workshop, investment is half more at 32.5 % DM than 27.5 % DM and 100 % more at 35 % DS. Anyway ROI is in favour of additional pressing because of sugar recovery and lower energy consumption. It is worth to mention actual R&D programs in PEF (Pulse Electric Fields) that can be promising to increase beet pressed pulps DS besides press technology.

## **Pulp Pressing-Belt Dryer – 3 Pass Dryer:**

In that process we gather 3 here above described technologies. Main data are in the scheme. 3 PASS DRYER 110 U.S. gpm (14.7 ft<sup>3</sup>/min, 25 m<sup>3</sup>/h) evaporating capacity produces vapour that is condensed to heat enough hot water to increase 2 456 874 U.S. gpm (328 494 ft<sup>3</sup>/min, 558 000 Nm<sup>3</sup>/h) fresh air up to 192.2 °F (89 °C) in finned tubes heat exchangers. Hot air can dry about one third of the pressed pulps. An option is to consider that the BELT DRYER is used as a predryer. If the BELT DRYER is installed as a dryer it allows producing very high quality of pressed pulps not degraded by temperature. This process can be installed in a beet sugar factory or in a distant drying unit. In that scheme according to our installations dust is lower than 25 mg/Nm<sup>3</sup> wet and VOC lower than 56 ppm (40 mg/Nm<sup>3</sup>) wet. Furnaces and exchanger can be designed to various fuels such as fuel oil, natural gas and biogas, coal, lignite, and wood. Very cheap fuel can be selected reducing again energy costs. This system can be a valuable consumer for biogas produced in an increasing number of digesters. As already mentioned instead of a condenser a juice evaporator can be put in place. In that case low pressure steam can be compressed with a steam ejector and used in the sugar plant. This technology has been used to concentrate vinasses and with compressed steam to feed a distillation column.

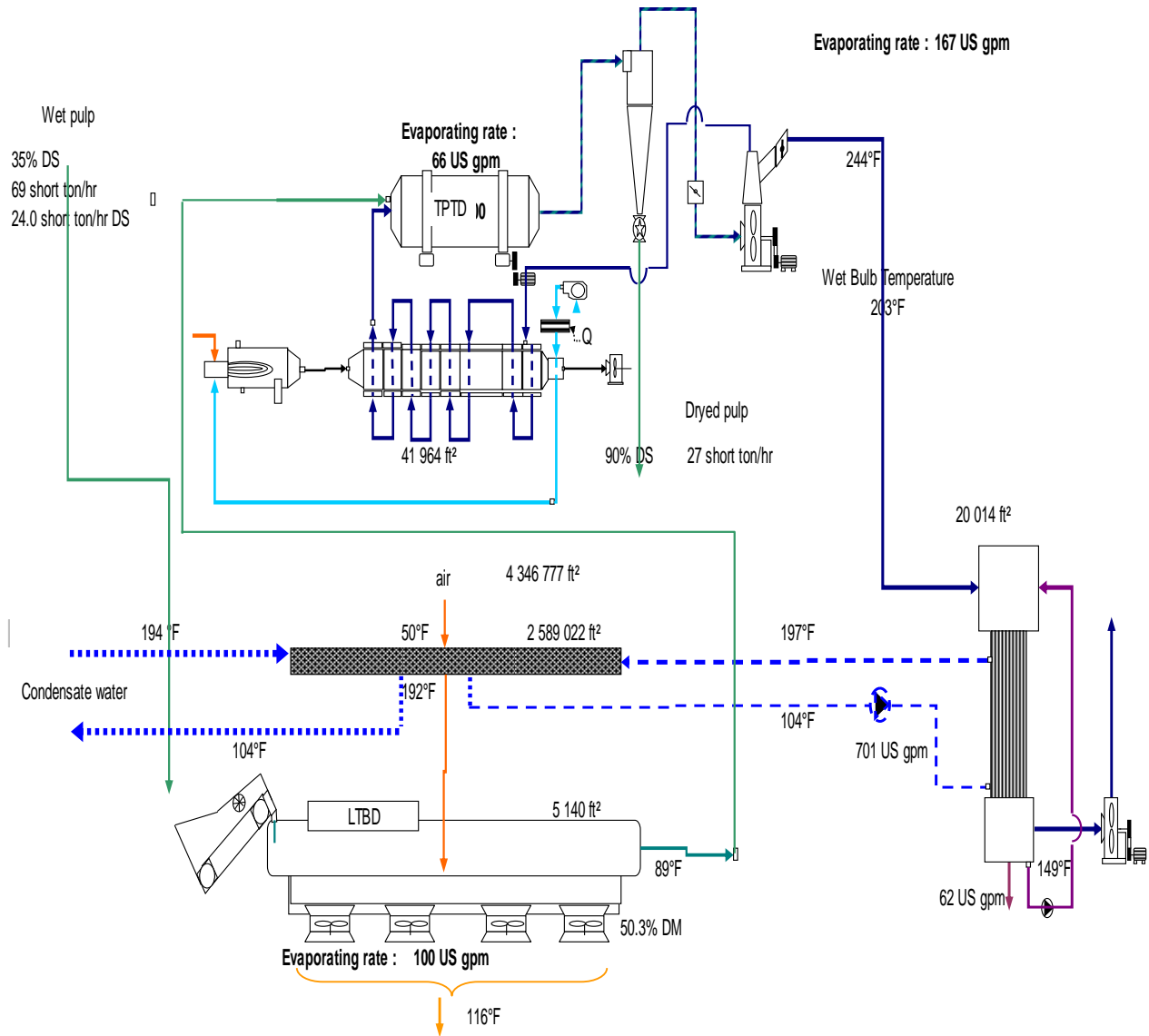
About power consumption the main consumers are the fans around 1,536 MMBtu/hr (850 kW) and 0.683 MMBtu/hr (200 kW) for the rest of consumers.





### **Pulp Pressing - BELT DRYER – 3 Pass Dryer – Plant Coupling:**

In this chapter we consider the same scheme above mentioned and BELT DRYER as predryer and we get additional hot water from the sugar plant. 1409 U.S. gpm (188 ft<sup>3</sup>/min, 320 m<sup>3</sup>/h), of hot water 194°F (90 °C) produced by the sugar plant have enough energy to supply BELT DRYER to evaporate 66 U.S. gpm (8.8 ft<sup>3</sup>/min, 15 m<sup>3</sup>/h) water from pulps. In that case the TPTD is designed to evaporate 66 U.S. gpm (8.8 ft<sup>3</sup>/min, 15m<sup>3</sup>/h) and provides enough energy to evaporate 35 U.S. gpm (4.7ft<sup>3</sup>/min, 8m<sup>3</sup>/h) in BELT DRYER. BELT DRYER evaporation capacity is then 101 U.S. gpm (13.5 ft<sup>3</sup>/min, 23m<sup>3</sup>/h). An additional 1.19 MMBtu/hr (350 kW) consumption with fans is necessary as hot air flow rate is nearly doubled. In this case fossil fuel used is lowered by 73 %. This scheme, among many others, is the one that can bring more flexibility as not fully intricate in sugar plant energy scheme. In this scheme hot water is used in process for diffuser and juice heaters. For diffuser the water is still available but at 104 °F (40 °C). In that case juice heaters will have to be fed by steam bleeding from last effect before condenser or before last effect and usually most multiple effect evaporation station can support that. It is more interesting to use hot water or even last effect bleeding steam from a multiple effect to the LTBD and it is possible then to increase LTBD capacity again depending on each site. One site has been fully connected to a LTBD in EUROPE (FONTENOY). Although this site is probably the lower energy consumer, some flexibility is lost as the dryer cannot function without the sugar plant. Many users needs to dry other products (Luzern) during inter season and are happy to keep an independent drying station. As mentioned before hot condensate water is not the only hot fluid available and in some cases hot vinasses, hot barometric condenser water, low pressure steam have to be considered to supply LTBD.



## **Conclusion:**

The process described in the paper can be adapted in a wide range of sites configuration and capacity. It is then a customized solution. Many options are possible to increase efficiency and reduce capital cost according investors choice. The solution helps to obtain a product of high quality using less fossil fuel energy (0 in case of biogas and wood are the selected fuel) and reducing dramatically VOC and dust emissions. Flexibility of the concept is high as energy supply is possible from the drying station to the plan via an evaporator or from the sugar plant via hot liquid fluids. The concept can be adapted in existing installations. The concept is in line with maximizing sugar recovery.