Reduced energy consumption for pulp drying in a high-capacity fluidized-bed steam dryer

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Political decisions affecting national and international trade are the primary cause for the increasing strains which the international sugar market finds itself exposed to. In this situation, the attention has to be directed at options that allow sugar production costs to be reduced in each sugar factory. We all know that the productions costs are very decisively influenced by the energy input, and most of you will have become aware of the rising fuel costs in recent years. At a time of growing world energy needs, this trend is not very likely to be reversed. Sugar factories hence have to consider technological measures in order to reduce their energy consumption and thus the costs of sugar production.

One promising option is available with pulp drying. The directly fired drying drums normally employed for pulp drying account for about 30 % of the overall fuel consumption of a sugar factory.

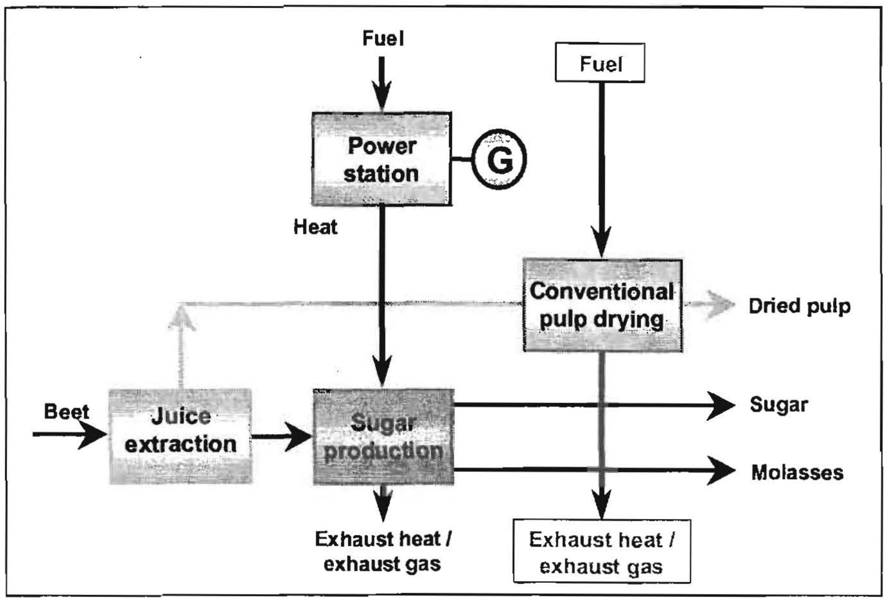

Fig. 1 Integration of a pulp drying plant into the energy system of a sugar factory-conventional

In terms of energy utilization, there is practically no link between conventional pulp drying and sugar production. The energy content of the required fuel can be put to efficient use only once. The only exception are the boiler flue gases, which in some factories supply about 10 % of the energy needed for pulp drying.
When using the pulp drying stage as a desuperheater and integrating it into the sugar factory heating system, almost complete economies can be made on the fuel requirements for pulp drying.

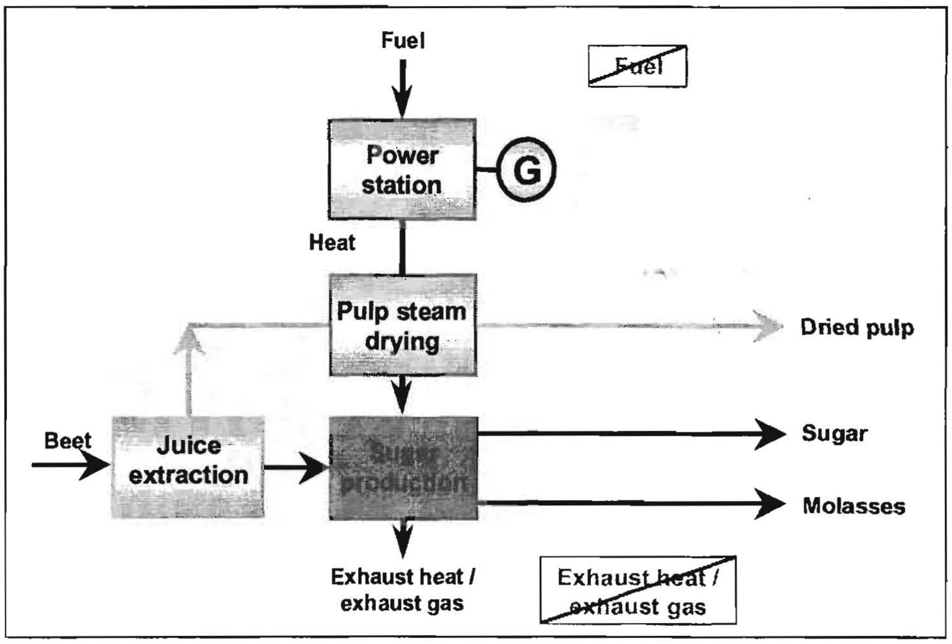

Fig.2
Integration of a pulp drying plant into the energy system of a sugar factory - steam drying

The fluidized-bed steam dryer is a technical solution that has been available for these purposes for some time. In this unit, the pressed pulp is dried in a circulating stream of superheated steam.

The thermal energy made available in the form of heating steam can be put to further use again after pulp drying as drying vapour at a pressure of about 3.8 bar (40.6 psig). Its energy content is normally utilized in the 1st evaporator effect. This benefit in terms of energy efficiency at the same time goes along with a substantially reduced environmental impact, because less CO_2 is emitted.

In the year 2001, BMA acquired an exclusive worldwide licence for the manufacture and supply of a high-capacity fluidized-bed steam dryer. Until 2001, the licenser Niro A/S had sold a total of 12 dryers of this type to sugar factories in Europe and the USA.

The operating principle of the Fludized-Bed Steam Dryer has been proven in practical operation and has already been presented in a number publications, as well as a paper read at the last ASSBT conference. This is why only a general overview of the structural design of the dryer will be given at this point.

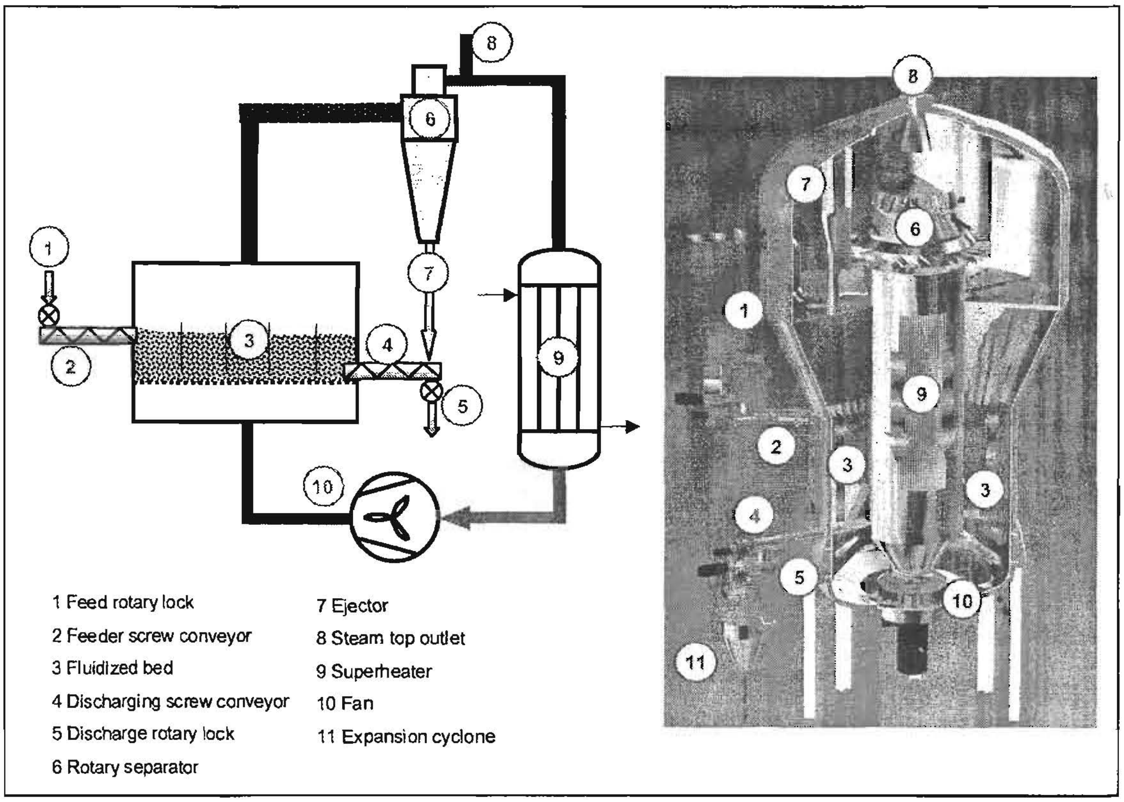

Fig.3 Operational Principle of the Fluidized-Bed Steam Dryer

In technological respects, the steam dryer consists of the following components:

- Fluidized bed with product inlet and outlet
- Dust separator with cyclone
- Side cyclone to discharge the separated fines
- Heat exchanger to superheat the circulation steam by means of heating steam
- Fan impeller with drive
- Distribution plate to distribute the circulation steam in the cellular fluidizing bed

The fluidized-bed steam dryer incorporates these components in a highly compact manner. In addition to the energy which the heat exchanger transfers to the circulation steam, heating panels are used to supply the fluidized bed with energy. Thanks to the direct contact between the pressed pulp and the heating panels, this energy transfer is highly efficient.

The bed of fluidized pressed pulp forms in an annular space in which 15 cells surround the central heat exchanger. The stream of circulation steam required for this purpose is generated by a fan impeller arranged below the heat exchanger. The dried pulp is extracted from cell No. 16 by means of a screw conveyor.

After having acquired its licence, BMA has supplied two steam dryers for pressed pulp to the German sugar factories Uelzen and Clauen. They differ from the licensor's previously supplied units in a number of respects. Modifications concern, in particular, the drying rate, which for the newly developed size 12 dryer has initially been rated for a nominal water evaporation of 50 t/h (55 sht/h). When compared to the largest such plants that have hitherto been installed, this provides for a 25 % increase in capacity at a steam pressure of 26 bar

(362.6 psig). Since, unlike most of the other large items of sugar factory equipment, the steam dryer is a pressure vessel, this largest dryer unit that has been produced to date represents a major challenge not only respecting design and manufacture, but also with respect to the transportation and assembly of the dryer segments.

BMA has developed the dryer in the first place with a focus on improving its availability during the campaign. Essential modifications in this respect are the following:

1. Mechanical and thermal disconnection of fan drive and fan impeller. For this purpose, a separate impeller shaft is installed in a bearing housing below the dryer.

2. Use of a dished distributor plate to improve pressed pulp fluidization.

3. Two feeder screw conveyors for pressed pulp supply into the fluidized bed. This is to prevent blocking of the fluid bed in the first dryer cells.

For a comparison of the availability of all steam dryers that have in the past been supplied by either Niro or BMA, complete fig.s are now available from plant operators for the 2003 campaign. The next fig. shows the availability figures presented at the Clauen meeting of steam dryer operators last year. These figures relate to the dryers with their immediately fitted equipment, without considering any peripheral cause for failure. The percentage rate shown is the actual operating period in proportion to the theoretical dryer operation during the campaign. The difference between 100 % and the percentage figure shown indicates failures caused by the dryer itself or its immediate equipment. These results illustrate that the dryer availability has in the meantime reached a very good level.

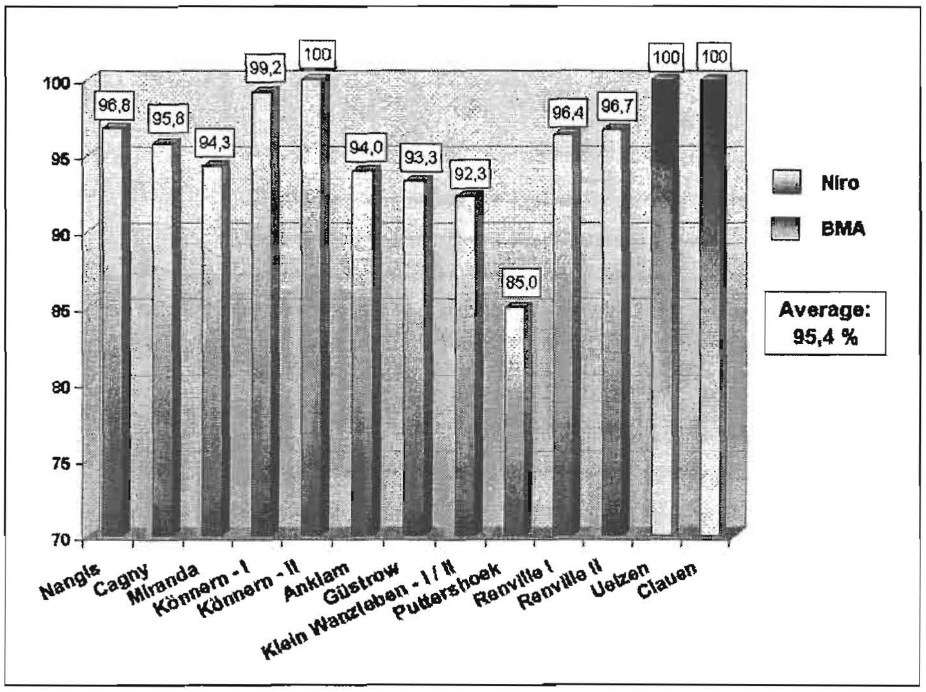

Fig.4 Availabilities of Steam Dryers supplied by Niro or BMA

Evidently, the modifications to which BMA has subjected its dryers can be regarded to be successful.

Availability data for the 2004 campaign are to date only known for the BMA steam dryer installed in the Uelzen sugar factory. In this case, the availability was about 96.5 %. Failure times were primarily due to the need of replacing the outlet lock rotor and shoes. These parts had been in operation in their third campaign and were affected by normal wear and tear.

For both BMA steam dryers, the water evaporation rate was demonstrated successfully in a performance run in their first campaign after commissioning. The performance criterion used is the amount of vapour produced in the dryer. This vapour is made available as a source of energy in the 1st evaporator effect, where it is condensed. For this purpose, the 1st effect of the Clauen sugar factory was converted into a falling-film evaporator with two calandrias. In the top calandria – 3,330 m² (35,844 sqft) – the steam dryer vapors are condensed, while the bottom calandria – 3,900 m² (41,979 sqft) – is supplied with turbine exhaust steam.

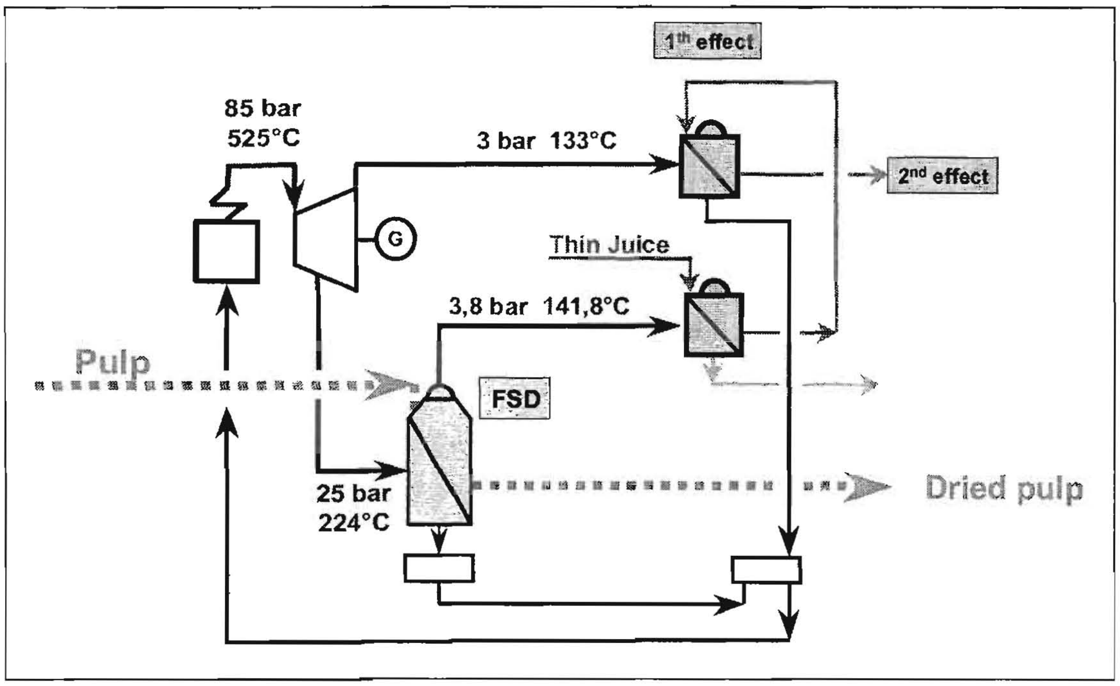

Fig.5 Integration of the fluidized-bed steam dryer into a heat system of sugar factory Clauen

The fig.6 is to serve as an example to illustrate the results of the performance run for the size 12 steam dryer.

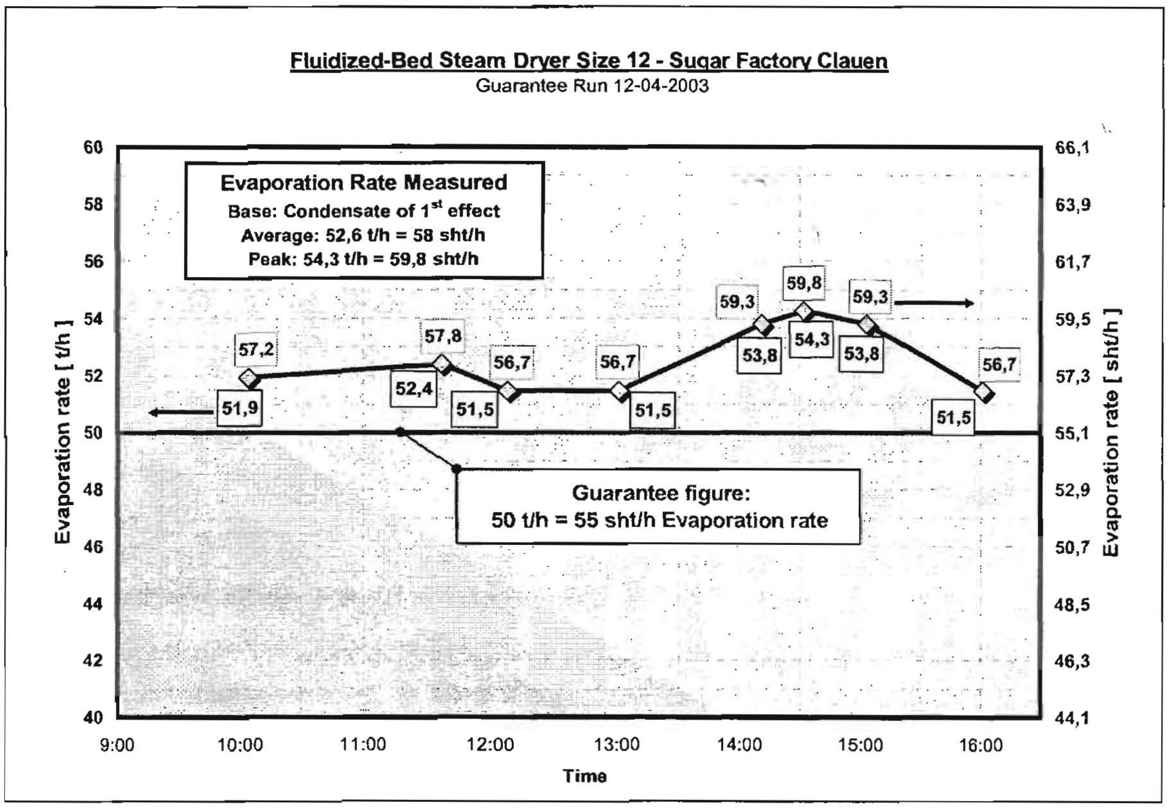

Fig.6 Fluidized-Bed Steam Dryer Size 12 – Guarantee run data

To demonstrate the water evaporation performance, the amount of condensate of the top calandria was measured. The performance run had been agreed to be an 8-hour run, but the customer asked it to be ended after just seven hours, because the promised water evaporation rate had clearly been exceeded at that point. Although it was intended to have the factory operate for the maximum slice rate during the performance run, the maximum capacity the steam dryer can achieve was unfortunately not reached. This was due to the fact that the incorrectly adjusted safety valves in the heating steam pipes and the vapour pipe were opened prematurely.

Fig.7 shows a detail of the performance data the Uelzen steam dryer achieved in the 2004 campaign and focuses on the parameter "vapor condensate" of the steam dryer after the first evaporator effect.

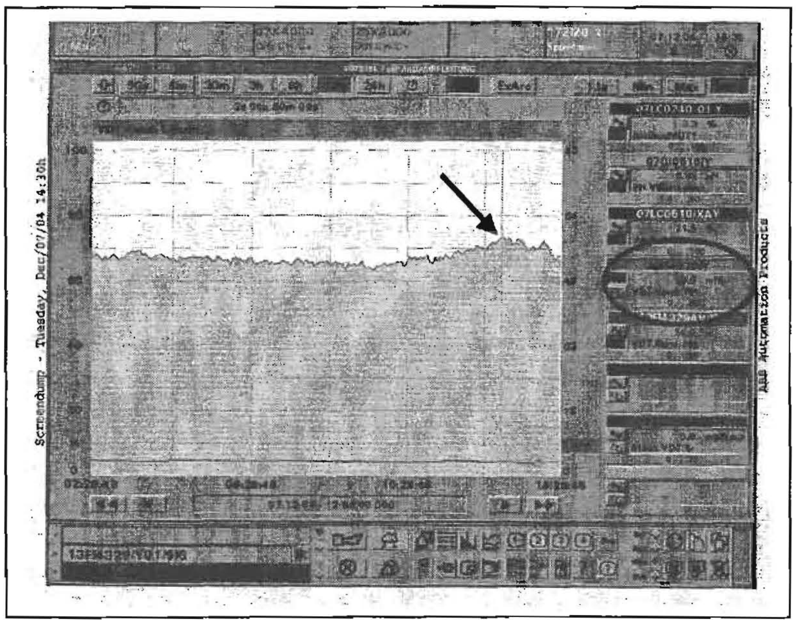

Fig.7 Water evaporation rate on bases of condensed vapors (Sugar factory Uelzen)

The continuous performance shown here is between 52 and 59 m^3/h (30.6 – 34.7 ft^3/min). According to the plant operator, peaks of more than 60 t/h (66.1 sht/h) water evaporation are also recorded, which is subject to the quality of the work done by the pulp presses. As for the pressed pulp rate (Figure 8), values of 90 t/h (99.2 sht/h) plus are attained. The pressed pulp throughput is represented by the pink-coloured curve in the middle of the graph. The yellow cursor highlights the value of 82.6 t/h (91.1 sht/h) recorded at that moment.

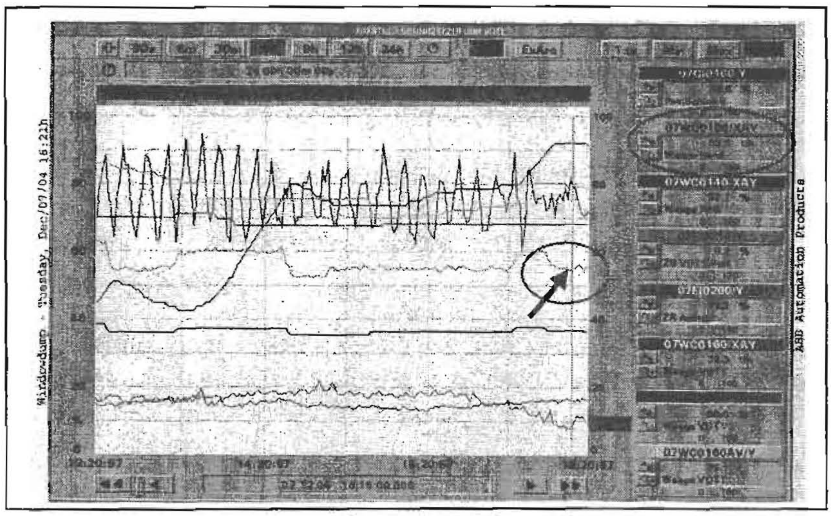

Fig.8 Pulp throughput (Sugar factory Uelzen)

The values attained in practice exceed by far the capacity for which the new size 12 steam dryer was originally conceived. In the light of this experience, the performance figures of the complete BMA-series have been updated (Fig. 9).

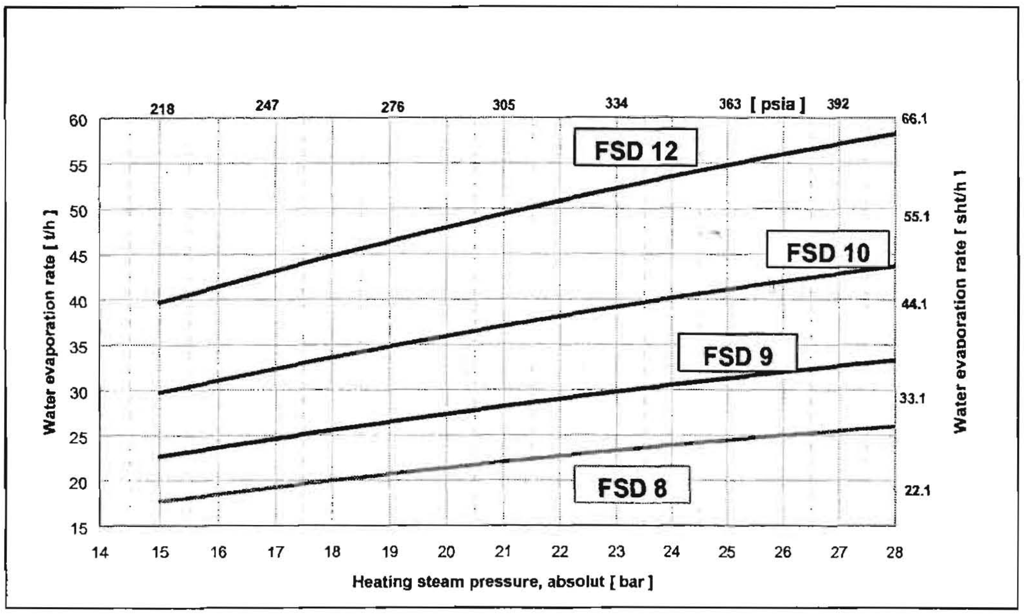

Fig.9 Attainable water evaporation rates with BMA Fluidized-Bed Steam Dryers

For smaller drying capacities, BMA offers the sizes 8, 9 and 10, which have also already been optimized in their design. For the basic water evaporation capacities as a function of heating steam pressure which the different steam dryer sizes offer, reference is made to.

With two size 12 steam dryers installed in sugar factories, BMA has furnished proof of its ability to successfully implement pressure vessel projects of these dimensions in practice. In view of the global interest the industry is showing in the fluidized-bed steam drying principle, it is interesting to note that BMA has not only obtained the European manufacturing certification, but also the ASME certification with the "U-stamp / U2" for pressure vessels. From engineering services to strength calculation to manufacture and installation, BMA thus provides a sound basis for the implementation of steam dryer projects.