Direct Desulfurization in Modular-Conception

SHORT INFORMATION

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H&C-VGU Direct Desulfurization Process for small and medium scale combustion plants

The new concept of the plant allows a flexible adjustment to different decision criteria

H&C-VGU Engineering GmbH offers a dry flue gas cleaning process (Direct Desulfurization) for thermal capacity ranging from 1 to 300 MW or even higher if the emission values are not too stringent.

The reason for offering this process in competition with wet flue gas desulfurization is that the advantages of wet FGD as high desulfurization efficiency, low operating costs and marketable by-product very often do not fulfil the decision criteria for a given site. Especially in east European and developing countries the application of direct desulfurzation has enormous ecological and economical advantages.

For many applications with a number of ecological and economical advantages

The legal boundary conditions allow in Germany the application of direct desulfurization to the plants up to 100 MW thermal capacity to get 50 % desulfurization efficiency and to the plants between 100 and 300 MW thermal capacity to get 60 % desulfurization efficiency. H&C-VGU recommends especially this process independent of plant capacity for older plants with low rest operating hours or new plants with low operating hours per year. Following are the major advantages of direct desulfurization for these applications:

Flexible adjustment to legal emission requirements

- simple design
- short planning and construction period
- minimum demand for qualified staff
- no effluent treatment

In the case of decision of the customer in favor of direct desulfurization the provision is made for future possibly more stringent emission regulations. The desulfurization plant can be retrofitted with the so called Eta-Plus-Reactor to reach sulfur capture higher than 80 %. This is possible with relatively low investment cost in comparison with wet FGD. Depending on fresh water and electric costs, a further

A great application field due to modular extension stages

implementation of heat displacement system can reduce the total operating costs.

The annexed table shows a quantitative comparison of costs between wet FGD and direct desulphurization.

High desulphurization efficiency per investment cost

In east European and developing countries the decision to build a desulphurization plant will be made from the point of view of minimum available financial resources. In the light of this fact, in these countries the focus must be put not on maximum attainable desulphurization efficiency but desulphurization efficiency per investment cost. Direct desulphurization attains a six times higher specific desulphurization efficiency compared to wet FGD.

Considering the electricity shortage and severe CO_2 problems facing these countries at the present and in the future, the direct desulphurization gains, even higher priority because its electric consumption is only 8 % of wet FGD.

H&C has decided to offer this modular concept of direct desulphurization, because all the afore mentioned facts shows that this concept offers the best solution from economical and ecological point of view in numerous applications.

Many sided proven plant components

In addition to that almost all the components involved in this technology have been laid out and designed by us. their reliability has been proven in a number of plants worldwide. The available experience and know how result in short planning period and minimize the technical risk extremely.

Process description

Under Direct Desulphurization Process (DDP) we understand the chemical capture of sulphur within boiler furnace itself.

The method of direct desulphurization discussed here is the absorption of sulphur by the basic sorbens $CaCO_3$ (powdered limestone) and $Ca(OH)_2$ (slaked lime). When $CaCO_3$ or $Ca(OH)_2$ are employed as the additive for pollutant capture, an endothermic decarbonising or dehydration reaction (calc Page 3 of 5ination) takes place in the furnace in accordance with

the following reactions.

$$CaCO_3 \rightarrow CaO + CO_2$$
or
$$Ca(OH)_2 \rightarrow CaO + H_2O$$

The CaO particles react with oxides of sulphur and other pollutants like halogens according to the following exothermic reactions:

$$CaO + SO_2 + ½\ O_2 \rightarrow Ca\ SO_4$$
$$CaO + SO_3 \rightarrow Ca\ SO_4$$
$$CaO + 2\ HCl \rightarrow Ca\ Cl_2 + H_2O$$
$$CaO + 2\ HF \rightarrow Ca\ F_2 + H_2O$$

The calcium products together with fly ash will be separated in the filter at the back end of the boiler.

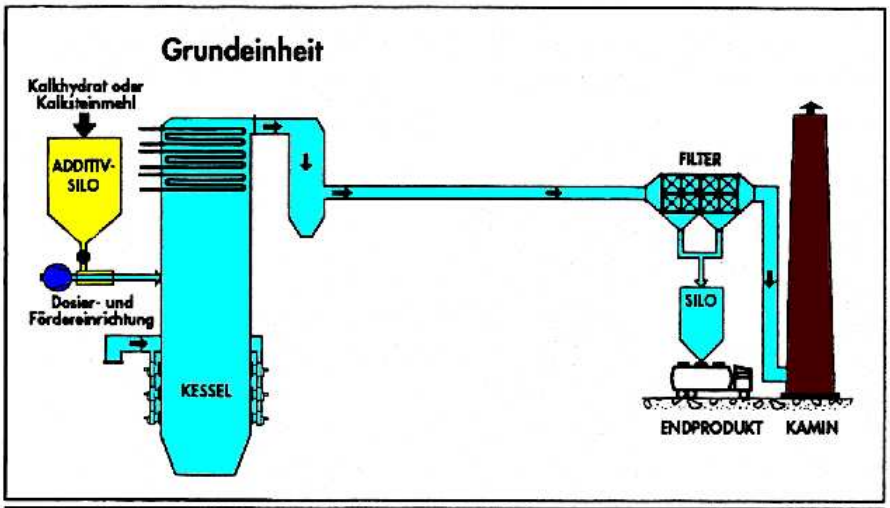
The basic unit of direct desulphurization can be added with a Eta-Plus-Reactor in a modular design to get higher sulphur capture and increase the calcium utilization. The conditioned water is injected into Eta-Plus-Reactor to reactivate the free calcium for further absorption reactions. The flue gas will be cooled down, the water vapour pressure increases and the following reactions take place in the Eta-Plus-Reactor.

$$CaO + H_2O \rightarrow Ca(OH)_2$$
$$Ca(OH)_2 + SO_2 + H_2O + ½\ O_2 \rightarrow Ca\ SO_4.2H_2O$$
$$Ca(OH)_2 + SO_2 \rightarrow Ca\ SO_3.H_2O$$

The concept of direct desulphurization with Eta-Plus-Reactor can be added with heat displacement system to save water and heat demand keeping the desulphurization efficiency high.

	Wet flue gas desulphurization with $CaCO_3$	Direct desulphurization with $Ca(OH)_2$		
Process	FGD	Basic process	Addition with Eta-Plus-Reactor	Addition with fly ash recirculation
Calcium consumption Ca/S	1.05	2	2	2
Desulphurization %	>95	>60	>80	>75
Water consumption %	100	0	40	5
Electric power %	100	8	30	12
Effluent %	100	0	0	0
By-product	Building gypsum $CaSO_4.2H_2O$	Fly ash+$CaSO_4$	Fly ash +$CaSO_4$ +$CaSO_3$	Fly ash +$CaSO_4$
Investment costs %	100	10	25	20
Operation costs %	100	150	170	160
Construction time %	100	30	40	40
Desulphurization efficiency per investment costs %	1	about 6	about 3	about 3.5

Comparison of desulphurization processes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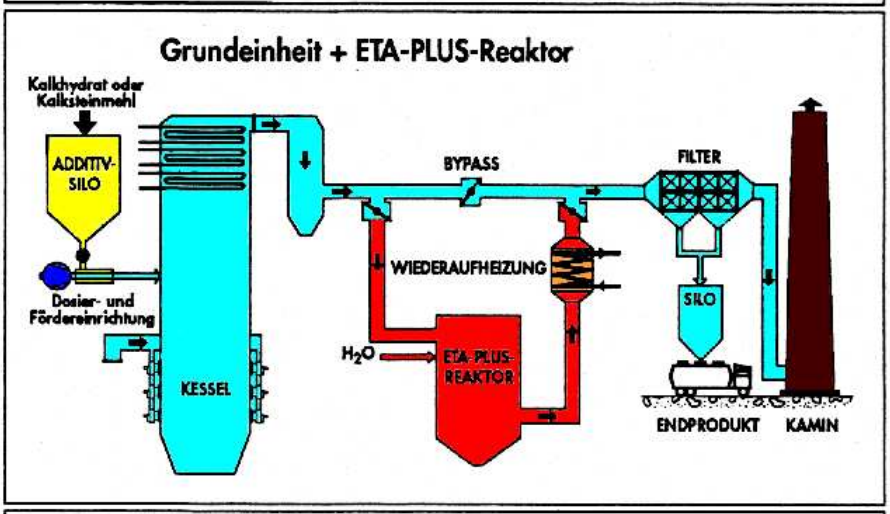
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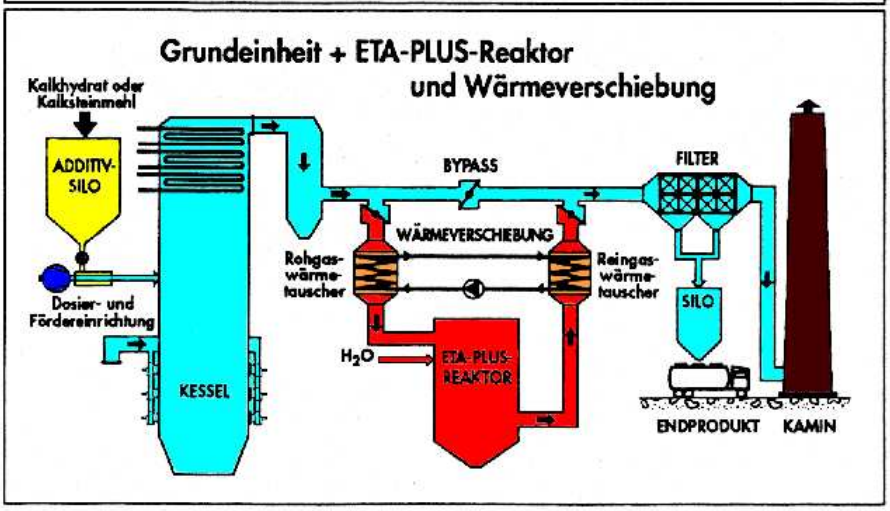
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