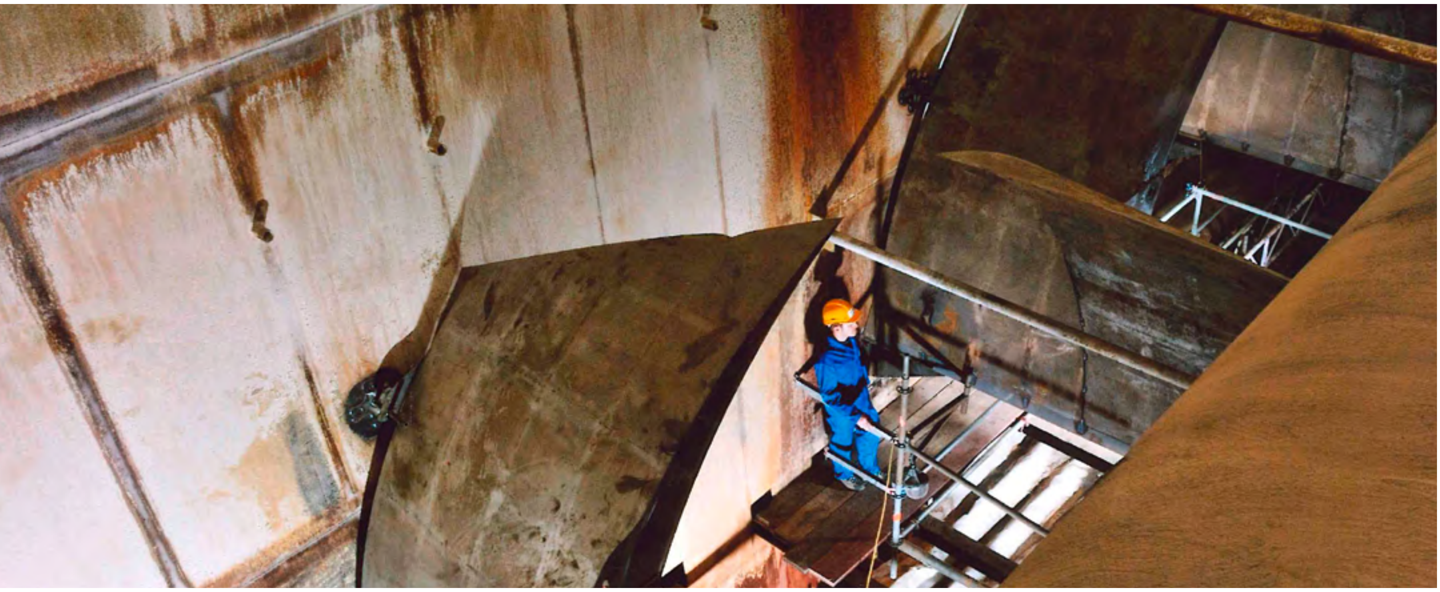


1 Installation of the ContourTM mixer from Sulzer into the flue gas duct of a power plant of GKM, Mannheim, Germany.

Flow Optimization for Large Gas Ducts

Huge amounts of fossil fuels are burnt in large combustion plants such as power plants, refineries, or cement works. The flue gas generated in these combustion processes needs to be cleaned to protect our environment. Sulzer offers technology for flue gas ducts to make these flue gas cleaning systems more economical and efficient.

Blowers are used to transport streams of gas in large combustion plants. Powering these blower devices is energy-intensive and cost-intensive. A minimized flow resistance in the system lowers the operating costs remarkably. Sulzer is constantly developing new methods and products to optimize flows within the ducts.

With the help of computational fluid mechanics (CFD), Sulzer's engineers calculate the flow velocity of the gas. Optimizing the flow reduces flow detachments, vortices and pressure drops. Thanks to the CFD simulation and subsequent analysis, Sulzer customers are assured that their new installations or retrofits (Fig. 1) meet the required operating conditions and legal standards.

EcoSpand — the new, patented duct insert

Blowing devices in gas ducts have a smaller diameter than the ducts themselves, and they deliver the gas with a high speed into a large duct. In doing so, a big part of the blower performance is lost. Inserting EcoSpand into the expansion duct helps recover the pressure. There is not always sufficient space inside the building to build the gas duct behind the blower for optimal flow. The building may not be large enough or other devices of the facility may be in the way. If you recall how loud wind is when it blows around the corners of a house, then you'll have some idea of how loud it can be when air does not flow optimally. In combustion plants, a splitter attenuator is often installed after the blowers so that the noise emissions comply with the legal regulations. The use of these sound absorbers directly after the blower results in an additional loss of the blower power. If there isn't an absorber in place, the vibrations generated may damage the system.

Better blow performance without vibrations

To make the gas ducts more efficient and the work more economical, Sulzer has developed a new, patented insert for expansion ducts called EcoSpand. This EcoSpand insert is installed in the duct after the blower or before the sound absorber, or wherever the diameter of the duct is enlarged.

How EcoSpand tames the gasflow

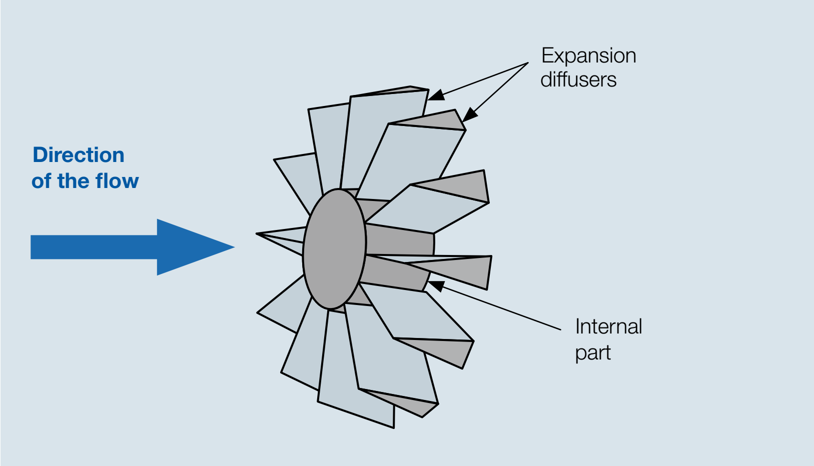
Several expansion diffusers are positioned in the shape of a star on a conical internal part that tapers in the direction of the flow (Fig. 2). These expansion diffusers divide the gas flow into several individual streams — like a ship's keel in the water. Since their wedge shape optimizes the flow, i.e. narrow at the front and wide at the back, the expansion diffusers offer little resistance to the gas flow. Behind the expansion diffusers, the individual small gas flows swirl, and there are targeted flow detachments and hardly any vibrations. With EcoSpand, the velocity of the gas is equalized over the entire diameter of the gas duct and less dynamic blower performance is lost than without EcoSpand (Fig. 3).

Individual design

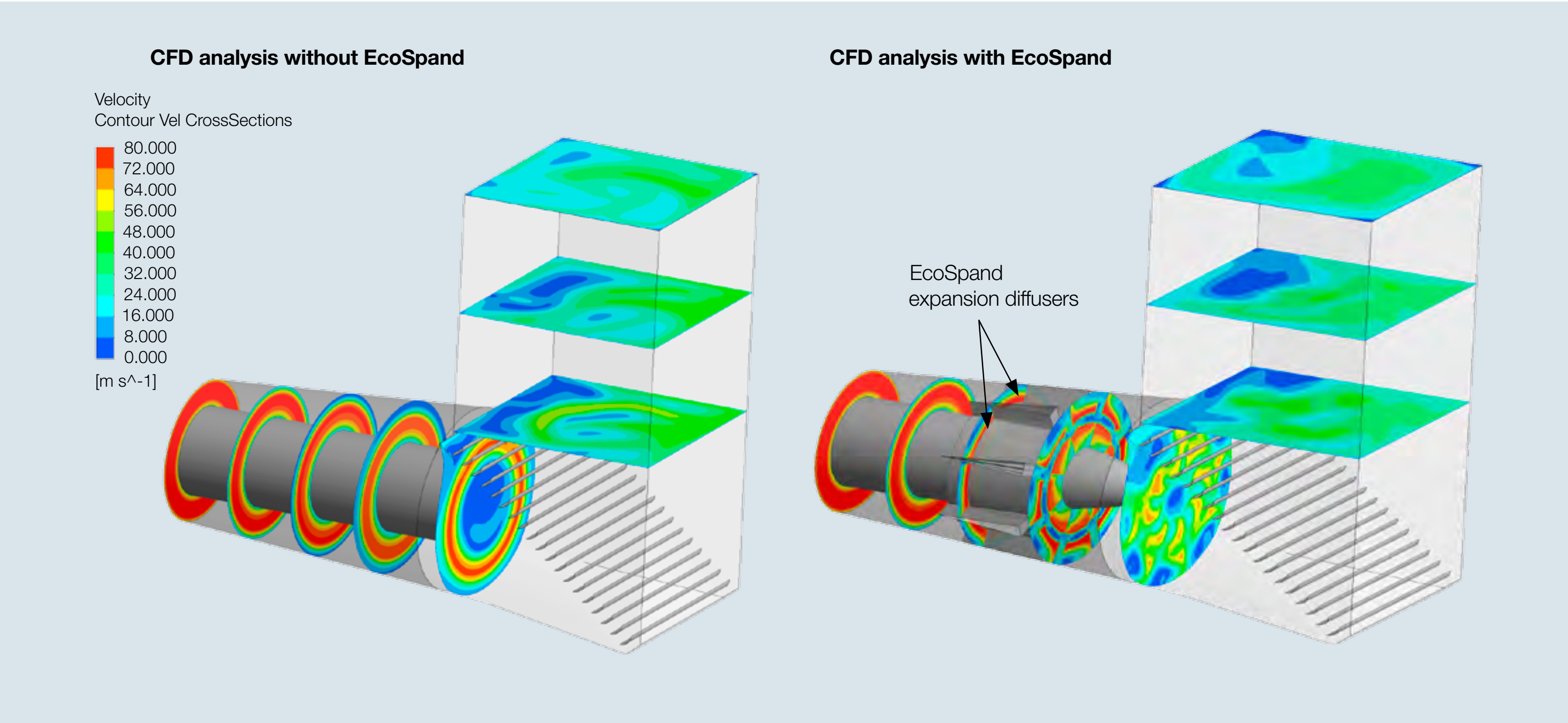
The reduction of the vibrations with EcoSpand is impressive, and plants could be able to operate without downstream sound absorbers.

The EcoSpand device is available in individual designs for the different areas of use:

- Standard (use without sound absorbers)
- Combined with sound absorbers (with reduced noise suppression capacity)
- Combined with dosing mixers and premixers



2 The EcoSpand expansion diffusers in the gas duct separate the gas stream.



3 CFD analysis of the distribution of the velocity in the gas duct (left without EcoSpand / right with EcoSpand).

Premixing grid — ideal for short mixing lengths

Conventional static mixers sometimes reach their limits when mixing hot and cool streams of air or gas over extremely short mixing lengths. To mix two similarly large streams of gas homogeneously over a very short mixing length, Sulzer has designed a premixing grid. One use for this premixing grid would be to set it right in front of the biomass grinder during the tempering of the air in biomass power plants. The premixing grid mixes the two flows through intensive predispersion (Fig. 5, D). At the same time, the main flow only exhibits an extremely low pressure drop during the through-flow of this mixing grid. This mixture works not only with two flows of the same rate but also when the flow rates are different.

Mixing and flow control with very low pressure drop

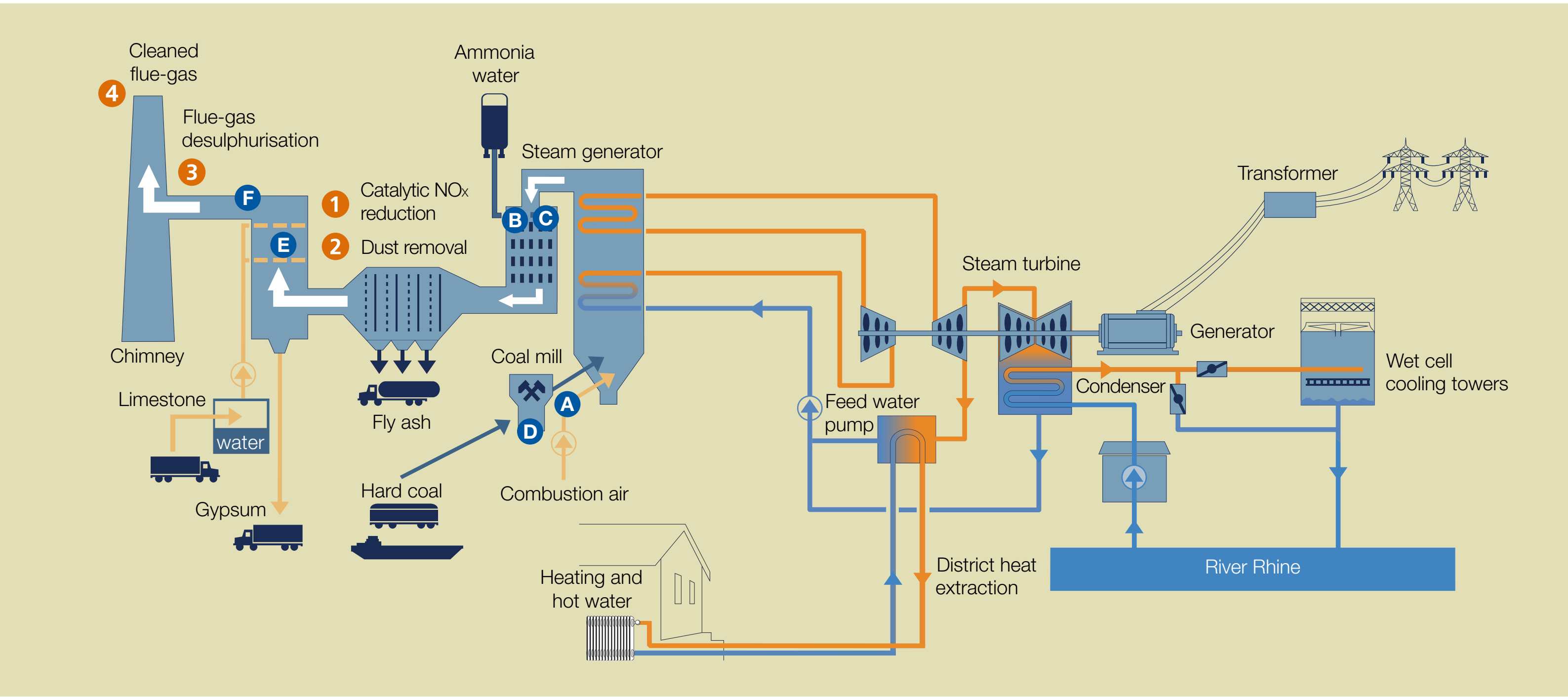
Selective catalytic reduction (SCR) is often used to reduce nitrogen oxides in flue gases from combustion plants, gas turbines, or internal combustion engines. The chemical reaction to the SCR catalyst is selective and preferentially reduces nitrogen oxides (NO, NO_2). For the catalytic NOx reduction (detail 1 in Fig. 4), it is essential to have a homogeneous admixture of ammonia and a consistent temperature for the process — that is where the mixers come into use.

Static mixers are used more and more frequently before SCR reactors, before electrostatic precipitators, or after flue gas desulfurization. A low pressure drop is achieved using the Contour mixer — under 1 mbar — and this goes along with an excellent mixing performance. After an in-depth consultation, Sulzer engineers can adapt the Contour mixer (Fig. 5, B) to suit the customer's specific requirements. The wing geometry is adapted to the diameter of the duct and the existing mixing line. In addition, the Contour mixer can be designed in such a way that it generates co-rotating or counter-rotating vortices. Thus, the mixing process can be optimized during engineering.

It is the ideal choice if ammonia water or urea solution is to be atomized through nozzles for ammonia dosing. Sulzer offers a proven, safe process method for optimized dosing ratios of ammonia after the Contour mixers. Because of the lightweight construction of the Contour mixer, there is no need to additionally reinforce the duct when it is being installed into existing ducts. This makes retrofitting easy (Fig. 1, page 11).

Dispersion of dust or ash particles

In certain practical applications, the flue gas flow contains high levels of ash or dust particles. In some cases, these particles have to be selectively separated and, in other cases, they need to be dispersed evenly in the flue gas stream. If the SCR catalyst is positioned directly after the boiler — i.e., the dust



4 Flue gas cleaning in practice — example from the coal-fired power plant Block 9 (Source: GKM, Mannheim, Germany).

has not been removed beforehand — it is preferable to disperse the dust in the flue gas as uniformly as possible (detail 2 in Fig. 4). This prevents the expensive catalyst from being worn on one side. To meet customer requirements, Sulzer engineers can use CFD analyses to position the SMV mixer in such a way that the dispersion of the dust particles occurs before the catalyst is homogenized. This increases the service life of the catalyst and improves efficiency.

Improved separation of the sulfur dioxide

Normally, to separate the sulfur dioxide contaminants (SO_2) in coal-fired power plants, a limestone suspension is injected into the flue gas (detail 3 in Fig. 4). This method has proven to work well and the gypsum that is created is further processed in the construction industry. However, in cases where injections do not disperse the limestone suspension sufficiently, the level of separation of SO_2 falls short of the strict emission guidelines. Sulzer's development engineers have designed special grid packings to increase the amount of separation. The grid packings (Fig. 4, E) provide for a very homogeneous distribution of the limestone suspension and, therefore, for very high SO_2 separation levels (over 35 mg/Nm^3). These are required by stricter regulations in more and more countries. At the same time, the suspension on the grid packings is used to remove dust from the flue gas, so that operators can achieve even extremely demanding limit values for dust in the flue gas (less than 10 mg/Nm^3). Despite this remarkable efficiency, the grid packings barely create a noticeable increase in pressure drop (pressure drop below 1 mbar). Sulzer offers a wide range of droplet separators (Fig. 4, F) that are highly efficient. These can be installed after flue gas desulfurization so that no drops containing sulfuric acid end up in the environment.

Individual, efficient and economical

Since combustion plants are customized and no two plants are the same, the flow optimization shown through CFD simulations is very important in the design phase of the plants. CFD simulations form an integral part of the project-specific consultation process with the customers and the development of new products. The efficiency and cost-effectiveness of the plants can only be verified prior to construction on the basis of these calculations, and it is becoming more and more important for demonstrating the plant's compliance with legal regulations.

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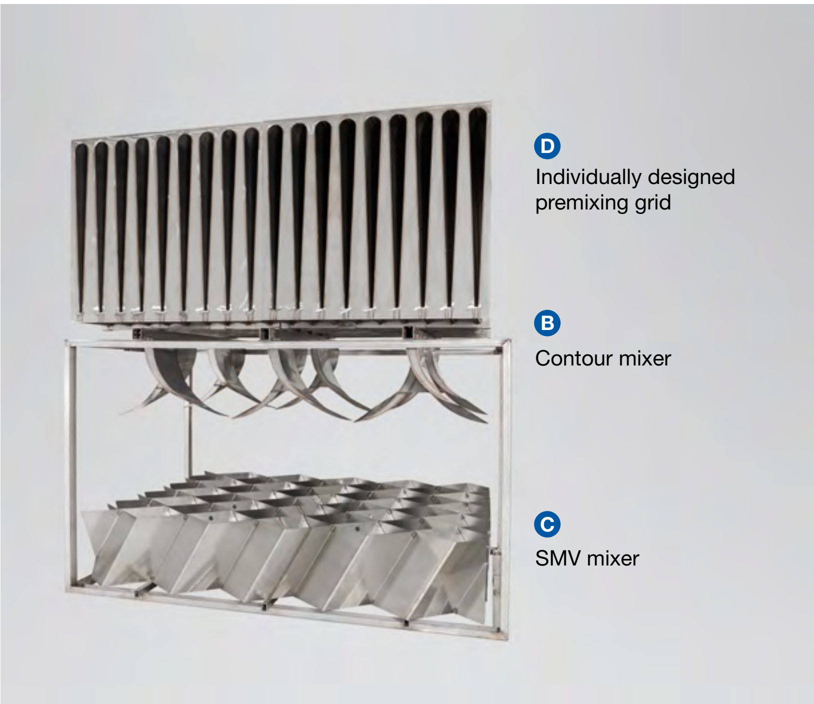
How flue air cleaning is achieved in a modern coal-fired power plant

1. **Removing the NO_x:** Nitrogen oxides (NO_x) are removed from the flue gas using catalysts and ammonia water.
2. **Removing the dust:** The dust particles are separated from the flue gas in an electrostatic precipitator. The dust is negatively charged and deposited on positively charged metal plates.
3. **Flue gas desulfurization:** The lime-gypsum process is used to desulfurize the flue gas. The sulfur dioxide (SO_2) is converted into gypsum using a suspension of ground limestone and water.
4. **Cleaned flue gas**

Various Sulzer solutions can be integrated into this flue gas cleaning process in order to increase efficiency:
A EcoSpand expansion duct B Contour mixer
C SMV mixer D Premixing grid E Grid packing
F Separators for droplet separation



5 Customer-specific combination of three mixers for the homogenized temperature of gas flows.