Innovations from Venti Oelde

Sound waves free fan impellers from dust deposits

Venti Oelde

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In many processes gases are transported which carry dust particles. Dust deposits, however, have a negative effect on efficiency and in the worst cases can cause plant downtime. If deposits cannot be prevented by constructional means, they have to be cleaned off. A simple process uses sound waves for this purpose. Cleaning by means of sound is effected while the plant is running. The result is high availability and low costs.

Remarks

Deposits and caking have always been the cause of plant downtime, resulting in expensive repairs, which it is possible to avoid. Deposits in ducts and pipes narrow the cross section and increase the flow velocity. The result is increased flow resistances, reducing the flow volume of the fan. This throttling effect can be considerable because the flow resistance increases to the square of the flow velocity. If the deposits increase further and the fan is operated to the left of the culmination point as shown on the characteristic curve, in extreme cases the flow volume can be reduced to such an extent that the conveyor system becomes completely blocked.
Generally the dust load in the gas stream is not sufficient to completely block the system. Usually the flow volume will decrease to the point that there is a considerable influence on the process. Deposits in the fan have proved particularly serious. In almost every case they resulted in unbalance and uncontrolled vibrations with increase of shaft and bearing loads, causing considerable damage because of the continuous effects.

Alkali chlorides and clay cause deposits

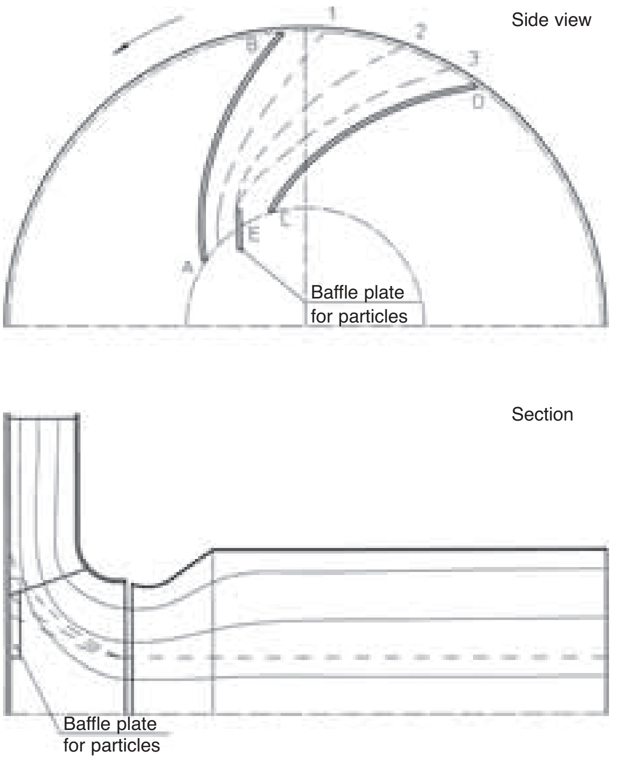
Now and again deposits on blades and impellers can be reduced, but never completely avoided, by the insertion of baffle plates which alter the flight path of the dust particles. In practice the deposits can often only be reduced or displaced but not completely prevented, meaning that cleaning is inevitable.

The cause of a deposit is usually the composition of the dust. Sample testing has shown that primarily iron oxides, alkali chlorides and clay promote the formation of deposits. Sediments lead to a hard, firmly fixed cake, because the heavy dust particles impact at high velocity on the forward side of the blades. Alkali chlorides especially encourage deposits when there is a dust concentration in the gas. For example, a gypsum content of about 8 % in the material from a cyclone air separator will encourage deposits on the reverse of the blades. These deposits have often been analysed and they consisted to 25 % of fine gypsum particles.

Further factors are:

- Particle size composition
- Temperatures during start-up and running down (not reaching the dew point) and temperatures > 40 °C
- Humidity content
- Pouring angle of the dust
- Flow velocity
- Aerdynamics of the impeller

Increased alertness is necessary when handling dust-laden gases in chemical plants because deposits can occur which endanger the whole plant



Constructional measures, shown here as a modification of the particle flight path 2 and 3, through the insertion of a baffle plate

The causes leading to the formation of deposits cannot be countered with one single measure. Suitable remedies include:

- Constant operation and, therefore, constant material feed
- Constant material quality
- With kiln operation, constant fuel feed, fuel quality and temperature
- Correct operation of cyclone heat exchanger
- Closely shutting rotary airlocks, double pendulum valves
- Correctly functioning air circulation and table air separators
- Avoidance of unnecessary interruptions in operation and cases of the dew point not being reached.

If these measures are not successful, then constructional modification or regular removal of the deposits must be considered.

One counter-measure is not sufficient

The most usual cleaning processes are compressed-air cleaning with fixed nozzles, cleaning with river sand or gravel, cleaning the opened fan when it is at a standstill and cleaning with sound waves.

Recently, cleaning with sound has proved successful both technically and economically. First results, supported by measurements, from the cement industry and general industrial engineering are promising.

Acoustic cleaning makes it possible for the small and smallest dry particles, such as raw meal, alkali dusts, cement, limestone, gypsum, soot, power, meal, etc. to be removed from all kinds of surfaces or to prevent their caking.

It is, therefore possible to free fans, filters, boiler plants and many more components from caking or even to prevent the dust particles from caking.

Cleaning with sound waves

Cleaning with the help of sound waves ensures the availability and efficiency of the plant and may even improve them. Cleaning can be carried out during normal operation, without interrupting the process. Thus costs arising from plant downtime are avoided and automatic operation is possible. The physical principle of cleaning with the aid of sound waves is really quite simple. Air sound pulses loosen the upper layer of particles, which is not firmly fixed, through reciprocal action. The cleaning effect is obtained through repeated subjection to sound.
The short activation of the pulses (about 0.2 s) reduces or prevents the stimulation of structure-borne sound as well as any vibration and transmission of structure-borne sound to other components. The length of the pulses must, therefore, be adapted to the size of the fan and/or system.

The provision of a standard solution in cleaning with sound waves appears to be improbable. The process must always be adapted to the specific conditions. Special acoustic cleaners are already being used successfully on fans, silo plants, bag filters, flue gas cleaning plants and drying plants in power plants, in the food industry, in the cement, limestone and gypsum industry and also in the metallurgical and chemical industry.

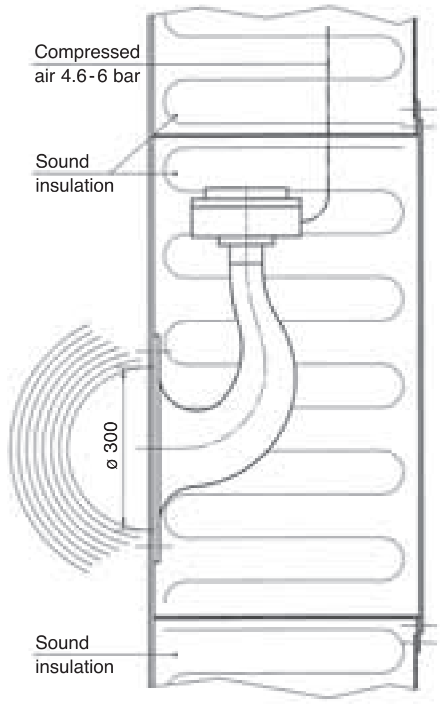
Prevention is better

The system is extremely effective as a preventive measure for the avoidance of caking. Because of their simple construction acoustic cleaners are considered to extremely reliable and economically interesting.
The following example shows the efficiency of this cleaning method.

An acoustic cleaner, supplied by compressed-air, is installed on an alkali bypass fan.
A partial gas-stream is taken from above the rotary kiln inlet and conveyed to the filter. The dust contained in the gas-stream is slightly sticky because of the high chloride content. It is deposited in the fan, mainly on the impeller. As a countermeasure, prophylactic cleaning is now carried out using an acoustic cleaner with two times four pulses per minute. The fundamental frequency is 250 Hz;
the operating pressure varies between 4.6 and 6 bar.
Through reflection the air sound pulse reaches many endangered spots in the fan and cleans off the first deposits with good results.

The fan has a flow volume of 210,000 m^3/h at 400 °C. The pressure difference has been determined as 6,500 Pa at 400 °C. The impeller diameter is 3,000 mm.
The acoustic cleaner has a curved shape (90° curve). This shape lessens contamination of the bell mouth during break periods.
The other technical data of this configuration are: air consumption 32 l/s during the sound pulse phases;
2 l/s cooling air consumption during breaks; application temperature 400 °C; maximum temperature 800 °C; material heat- and corrosion-resistant.

Acoustic cleaner



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Acoustic measurements showed a fan sound pressure level in this case without acoustic cleaner of 85 dB(A) at a distance of 1 m; main interference frequency 1,000 Hz; fan sound pressure level at a distance of 1 m with acoustic cleaner 101 dB(A); main interference frequency 250 Hz. This fan is installed in an unfavourable position between building wall and silo. It was impossible to ascertain the sound reflections which had increased the measurement figures.

Under free field conditions a sound pressure level of about 68 dB(A) at a distance of 50 m and of about 62 dB(A) at 100 m distance can be expected. It must be said that cleaning with the aid of sound waves is generally ineffective with materials which bake on solidly. The cycle times must be determined individually for each application. This entails continual cooperation between plant constructor and operator.

Venti Oelde

Ventilatorenfabrik Oelde GmbH
P.O. Box 37 09
D-59286 Oelde
Phone: +49 25 22 75 - 0
Fax: +49 25 22 75 - 2 50
info@venti-oelde.de
www.venti-oelde.de

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