CUT Operating Costs

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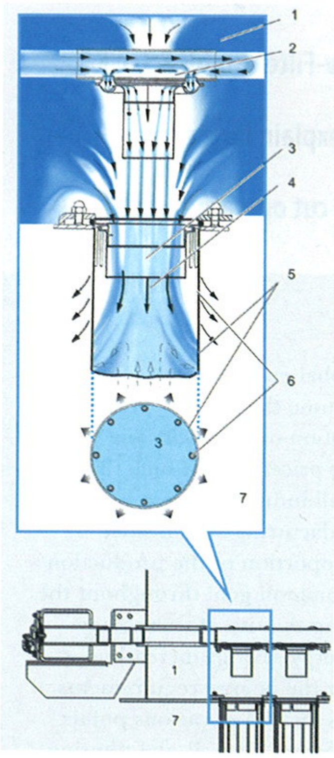
Introduction

It is estimated that by 2030 the global energy requirement will be 33 billion kWh. Experts assume that energy prices will continue to rise. The consumption of electricity will also increase in line with the rising price of fossil fuels. This prediction is forcing managers in all industry sectors to take action, including the cement manufacturing sector, since energy costs account for a large proportion of the production costs. Reducing energy costs is a common goal throughout the cement production industry, making the use of technology that offers the greatest possible energy savings increasingly necessary. In this respect, reducing the energy requirements for the existing filtering separators located at various points in the cement plant is highly significant. Overall, the filtering separators need to achieve high particle removal efficiency and must also be designed to minimise energy consumption.

Intensiv-Filter's goal is to significantly increase the energy efficiency of bag filters, as well as continuing to improve precipitator performance. Besides describing the main components and key functions of jet pulse bag filters, this article will address the question of the extent to which the specific energy requirements can be reduced through a combination of measures with regard to the design of the baghouse filter components as well as the jet-pulse cleaning control technology.



Legend	
1	Clean gas compartment
2	Coanda injector
3	Inlet nozzle
4	Cleaning gas
5	Filter bag
6	Supporting cage
7	Raw gas compartment

Figure 1. Detailed view of the Coanda injector – cleaning mode.

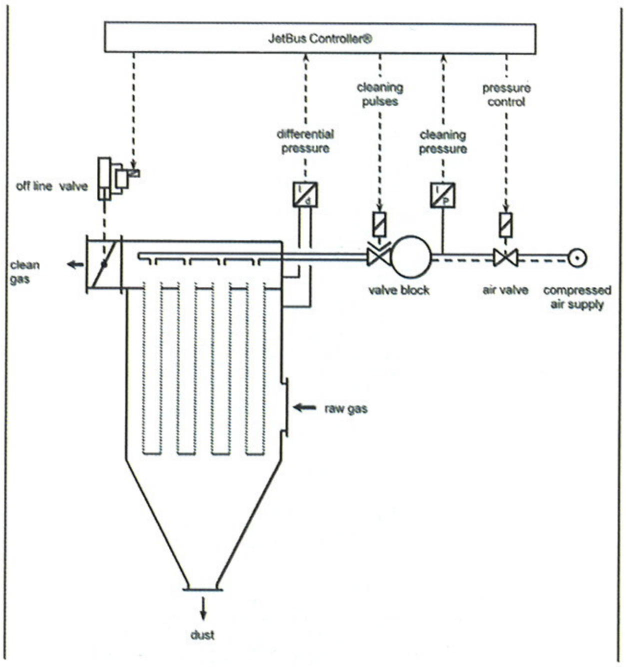


Figure 2. JetBus Controller® cleaning system, semi-offline operation.

The injector system

Conventional jet pulse filtering installations use up the majority (almost 60%) of their energy requirement to overcome the loss of pressure caused by the filter cake. The injector system determines the removal efficiency of the filter cake at a given tank pressure and is therefore one of the crucial factors for the pressure drop of the filter. The so-called "ideal nozzle" offers significant advantages over systems that consist of a blast pipe with a simple borehole serving as a hole-type nozzle. Applying ideal nozzles, the static energy is converted into a directed flow of compressed air with high efficiency, thus improving the cleaning power. A further significant improvement to the cleaning efficiency can be achieved by the Intensiv-Filter Coanda injector. The compressed air delivered by the blowpipe (Figure 1) emerges from the annular gap of the Coanda injector and follows the wall (boundary layer flow – coanda effect) in an axial direction. Due to the Coanda effect, the flow of primary air generates a powerful negative pressure in the interior. Subsequently, so-called secondary air is sucked in from the filter's clean gas area and the amount of air or gas flowing through the filter bag is significantly increased, effectively forming a free jet. This is applied to the second injector stage, located in the upper part of the filter bag, where additional secondary air is sucked in. The inlet nozzle in the second stage causes less pressure drop during the filtering stage than standard venturi nozzles or other inlet nozzles, as a result of its larger diameter. Due to the described combination of Coanda injector and Intensiv-Filter inlet nozzle, a maximum efficiency of converting the energy of the pressurised air into cleaning power is achieved.

Besides the high efficiency of the Coanda injector and, to a lesser degree, the use of an "ideal nozzle" (Intensiv-Filter nozzle system), it is possible to significantly reduce the use of compressed air in the cleaning system. Measurements have shown that the use of Coanda injector or Intensiv-Filter nozzle system results in significantly improved effective cleaning pressure in the bag compared with other simple injectors. It is important to remember that the pressure impulse of a cleaning impulse [Pa·s] – and consequently the cleaning intensity – is determined by the injector system used. To remove the filter cake along the entire length of the bag, a minimum overpressure or rather pressure impulse is required. The ideal nozzle and Coanda injector achieve these at lower tank pressures compared with the conventional hole-type nozzle. Improved injector systems therefore achieve a reduction in compressed air consumption and significantly higher cleaning intensities at a specified cleaning pressure. It has been proven that, regardless of the cleaning pressure in the compressed air tank, the pressure impulse and consequently the cleaning efficiency increases in the order: hole-type nozzle, ideal nozzle, Coanda injector.

The cleaning control system

The JetBus Controller® (Figure 2) regulates the cleaning of the filter bags. Based on microprocessor technology, it keeps the bag filter installation at an optimised filter differential pressure level by adjusting the cleaning pressure in the compressed air tank. The tank pressure varies from 0.1 to 0.6 MPa, depending on the cleaning

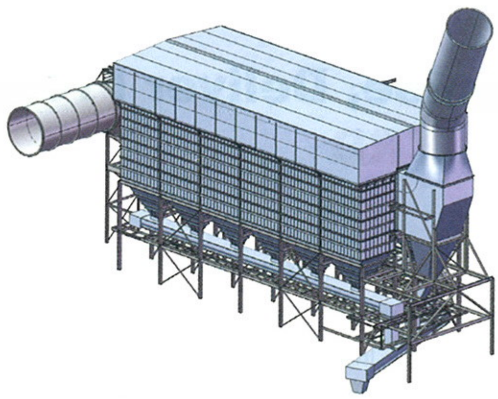


Figure 3. The new modular Intensiv-Filter ProJet mega® baghouse series.

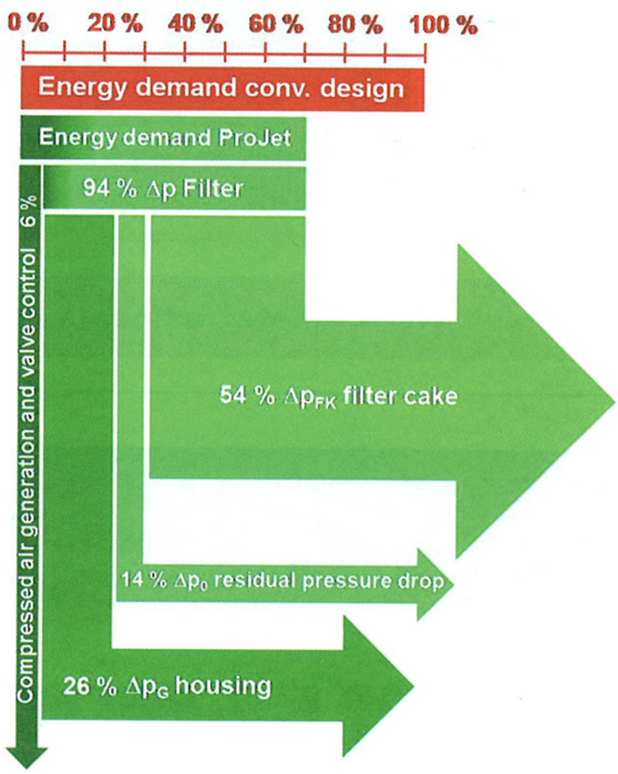


Figure 4. Reduced energy requirements compared with conventional design.

system. Consequently, cleaning is adapted to the operating conditions of the filtering separator and the system functions are parameterised flexibly. Depending on the application, cleaning intervals vary between fixed time control and differential pressure control with variable cycle times. The mechanical load on the filter bag can also be decreased by adjusting and minimising the tank pressure.

In systems operated offline, that is to say with an interrupted flow of gas in the chambers to be cleaned, the pneumatically or electrically activated clean gas and raw gas flaps are controlled by the JetBus Controller®. As an alternative to offline use, the system can be operated in semi-offline mode, where the clean gas side flaps are closed only.

Filter bag monitoring (broken bags) is possible in combination with continuous dust measurement in the clean gas area. Bag damage can be clearly identified from the increased emissions. The dust accumulation in the individual filter modules is also evened out as a result of the cleaning being adapted to requirements, so that the dust overload of the discharge will be prevented in each operating phase. Consequently, cleaning at low pressure results in a longer bag service life and also in lower noise emissions. Because the raw gas volume flow during cleaning is interrupted, the offline and semi-offline operation mode also prevents the redeposition of already removed dust layers. This clearly reduces the pressure loss caused by the filter cake compared to filters in online operation.

Improvements to the design

At Intensiv-Filter, fluid-mechanical improvements to bag filters and other installation components are realised using a powerful CFD programme (Computational Fluid Dynamics). This makes it possible to predict system behaviour in much greater detail than is allowed by traditional and costly test set-ups. The flow, pressure and temperature profiles of real systems, as well as the particle injectories, the heat transfer, vaporisation and drying processes, can be analysed numerically.

Several filter components, such as the inlet duct, the deflector plate and the geometry of raw gas flaps, have been optimised through CFD. The design improvements contribute to a reduction of both the filter-housing pressure loss and the abrasive flows.

All the measures described are implemented in the new Intensiv-Filter ProJet mega® bag filters (Figure 3). In keeping with the task of developing a filter with a reduced life cycle and instrument costs, the ProJet mega® series is standardised and based on prefabricated components and modular units. This newly developed series of bag filter installations can be operated in offline, semi-offline or online mode and are available from single head compact filters to big process filters with a bag length of 8 m and above. Consequently, a modern and modular filter series is realised, which offers various customer-specific solutions for volume flows of up to 2 million m^3/h and the most advanced measures to increase the energy efficiency.

Conclusion

The combination of a cleaning control system tailored to requirements, the high efficiency of the Coanda injector, semi-offline or offline operation, and the regeneration of filter bags at a low pressure level leads to a significant reduction in operating costs. The operating cost level of electrostatic filters is achieved by a 30% reduction in energy requirements, related to the energy expenditure required by a conventional bag filter to remove the dust from a gas stream. The first realised plants (e.g. replacement of existing ESPs by ProJet mega® baghouse filters) confirm this value. Filtering separators designed as bag filters also achieve significantly higher particle separating efficiencies than electrostatic filters. As a result of this, more and more electrostatic filters, which often do not adhere to required emission limits, can be replaced with powerful and highly efficient baghouse filtering installations.