SIEMENS
Ingenuity for life


160+
In Turkey
for Turkey

# Increasing efficiency in process fans at cement industry

## Energy efficiency services for cement plants

siemens.com.tr

# INCREASING EFFICIENCY IN PROCESS FANS AT CEMENT FACTORIES


## Metehan Karaca, Mert Kalpar
## Siemens Sanayi ve Ticaret A.Ş.,

## metehan.karaca@siemens.com
## mert.kalpar@siemens.com



## 1. Summary

Targets included in Turkey's 10th Development Plan include reducing dependence on energy imports, making energy cost sustainable, efficient use of energy, and most importantly protecting the environment. Energy costs and greenhouse gas emissions are becoming increasingly important in the Cement Sector, which is one of the leading sectors in this context. As is known, the cement sector is an energy intensive sector.Especially in this sector, ~60% of the cost comes from energy costs, so efficient use of energy has become the primary parameter that they have been paying attention to in recent years when determining the strategies. In this work, the process fans (Coal mill system fan, Farin mill system fan, Filter fan, ID fan, Clinker Cooling fan, Cement mill hot gas fan etc.) in Cement plants were examined in terms of energy efficiency. The average energy savings at Cement factories that can be achieved by using a frequency inverter in a damper controlled fan are given. In the Coal Mill ID fan, which is controlled by a damper for a sample plant, measurements and calculations made before the application for the frequency driver application, as well as the measurements made after the application, are given in detail and the amount of savings obtained, the payback period and the environmental equivalent of saving are specified.



**Key Words:** Cement, Energy Efficiency, Grinding Mill Fan, Abgaz Fan, Clinker Cooling Fan, Filter Fan, Variable Speed Driver


## 2. Purpose and Scope of the Work

The aim of the project is to examine energy saving in the Coal Mill Induced Draft (ID) fan in the Cement Plant

The mentioned ID fan is located at the exit of the coal mill. The ID fan carries the grinded coal to the filter or cyclone with forced draught. The flow rate of the fan is adjusted by the damper on the suction line.

In the scope of the work, measurements were made on the Coal Mill ID fan and data obtained from the plant.

Picture 1- Coal Mill ID Fan

This fan has operating conditions that vary according to process needs and these conditions are adjusted by the damper in the suction of the fan. In this type of centrifugal fan, it is not a preferred method to make the flow rate adjustment by the damper according to the process requirement in terms of energy efficiency. The aim of this project is to set the flow rate, which is proportional to the engine revolution, as the variable demanded, since it provides significant savings in energy consumption by providing a frequency driver to be connected to the electric motor.

## 3. Energy Efficiency in Fans

The gas required to meet the demand of the process can be set in three different ways in the fans. These methods include inlet damper, outlet damper and fan speed control. Almost all fans have been sized to provide the highest possible operating conditions in process.

### 3.1 Outlet Damper

Reducing the flow with outlet dampers creates extra friction and increases pressure losses. The damper increases the resistance of the system and forces the fan to operate at high pressure. With increasing pressure, the working point shifts to the left side of the system curve and the flow rate decreases. The fan's working point moves away from the best efficiency point.

### 3.2 Inlet Damper

Inlet dampers are more efficient control units than outlet dampers. However, frictional losses and turbulence will occur due to narrowing the cross-section process. Therefore, they are inefficient systems compared to variable speed drivers.

### 3.3 Adjustment of Fan Speed

The speed control method is the most effective fan flow control method. When the same hydraulic work is done in flow rate adjustment with speed control , we use less energy when it compared with damper control. If the fan is designed appropriately for the system, the performance curve and system power move toward the origin as the fan speed decreases. So, fan efficiency is kept at the highest possible level at varying flow rates.

Cutting the discharge line by a fan at the network frequency causes a significant amount of energy loss. This can be the case in many cement plants.

## 4. Frequency Driver Application to the Coal Mill ID Fan

### 4.1 Current State

The Induced Draft fan, which absorbs the dust generated during milling of the crushed stone, is sucking through the dust filters. The dust coming from the mill is held in this filter and the ID fan absorbs the air and transmits it to the chimney. Fan is controlled by the mechanical damper on the suction side. Depending on the grain size of the grinded coal, air sucks from the filters according to the damper aperture , which is entered into the automation system by a manual operation. This process, which is carried out continuously with automation control, is continued by varying the aperture of the damper by operator when grain size is changed.

When the system is switched on, the fan motor starts when the damper aperture is at 0% and then the automation system automatically switches the damper aperture to 40%. The automation system leaves the control to the operator after the damper aperture brought to 40%. The operator manually adjusts the damper aperture set to a value between 40% and 48% to adjust the mill according to grain(coal). All data are recorded and monitored in the automation system.

### 4.2 Results of Measurement

The average aperture of the damper in the Coal Mills ID fan obtained from the data in the scada system and worked at an average aperture of 45%. In order to confirm the aperture of the mechanical damper in the fan suction, two measurements were taken at 40% and 45% damper apertures and compared with current state and the original performance curves of the fan.

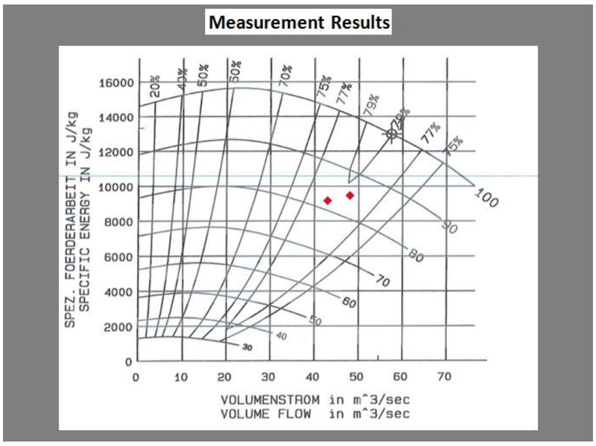
Flow rate and energy consumption measurement results are detailed below for ID Fan.

Tablo 1 – Measurements at %40 and %45 Damper Apertures

| **Measurement Results**<br>**ID Fan** | **1. Measurement** | **2. Measurement** | **Unit** |
|---|---|---|---|
| **Damper Aperture** | 40 | 45 | % |
| **Temperature** | 82 | 83 | °C |
| **Flow Rate** | 43 | 48 | $m^3/s$ |
| | 154.800 | 172.800 | $m^3/h$ |
| **Active Power Consumption at Measurement** | 770 | 810 | kW |
| **Frequency** | 50 | | Hz |

Using the data obtained from measurements made at 40% and 45% damper apertures, the actual damper aperture and the damper aperture read on the SCADA display were compared.

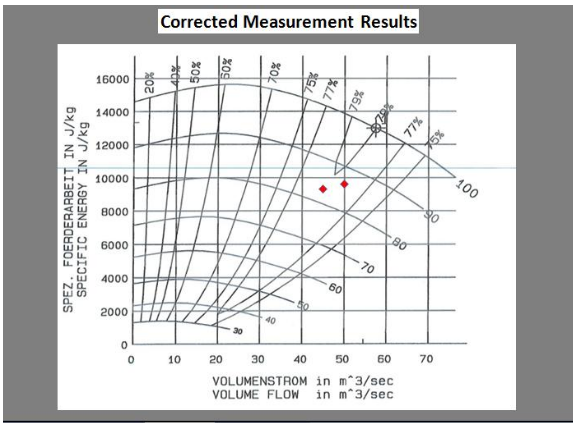
When we place the measurement data on the curve of the existing fan, the situation shown in the graphic below occurs.




Graph 1 - Display of Measurement Values on the Performance Curve

Reference point is at 90°C(for fan's original performance curve) but measurements made at 82 °C and 83 °C so necessary arrangements made for fan's suction measurement values according to 90°C.

After the measurements made with the Pitot Tube were corrected according to the 90 ° C temperature, the measurement points were placed on the original performance curve of the fan, and the actual damper apertures were correctly determined.




Graph 2 - Curve Display of Temperature Corrected Measurement Values

As can be seen from the above graph, it is determined that the 40% and 45% damper apertures in the scada screen actually correspond to the apertures of 39.7% and 44.6%, respectively, and the inlet dampers operate with a deviation of about 0.35% in the average.

The size of the fan being used and the fact that a mechanical damper is used means that 0.35 % is insignificant due to it is below 5% and the correctness of the damper aperture data read on the Scada screen has been proven.

In the ID Fan, controlled by the adjustment of the inlet damper with automation control, the energy consumption quantities according to the percentage of the damper aperture were determined by measurements.The effect of the flow rate reductions provided by the reduction of the inlet damper in the fans to the energy consumption of the fan motor is less than the flow rate decrease and it is not a good way to adjust the flow rate with the damper in terms of energy efficiency.

If the following table damper aperture decreases from 40% to 45%, there may be a change in the fan's energy supply and fan's energy consumption. In the ID fan, the decrease in flow rate from 45% to 30% of the damper aperture was 10,4%, while the decrease in energy consumption was only 4,9%. This shows us that the reduction in energy consumption is not as much as the descrease in flow rate when the flow adjustment is done by damper. However, if the same flow decrease was provided by lowering the fan speed with the frequency driver instead of the damper, the decrease in energy consumption would be much higher.

Table 2 - Calculation of Decrease in Energy Consumption in Different Damper Apertures

| **Calculation of Decrease in Energy Consumption in Different Damper Apertures** | ID FAN | Unit | |
|---|---|---|---|
| **Air Flow Rate** | | | Change in Air Flow Rate |
| %35 Damper Aperture | 172.800 | $m^3/h$ | - %10,4 |
| %30 Damper Aperture | 154.800 | $m^3/h$ | |
| **Amount of energy consumed by fan after throttle with inlet damper** | | | Change in Energy Consumption |
| %35 Damper Aperture | 810 | kWh | -%4,9 |
| %30 Damper Aperture | 770 | kWh | |

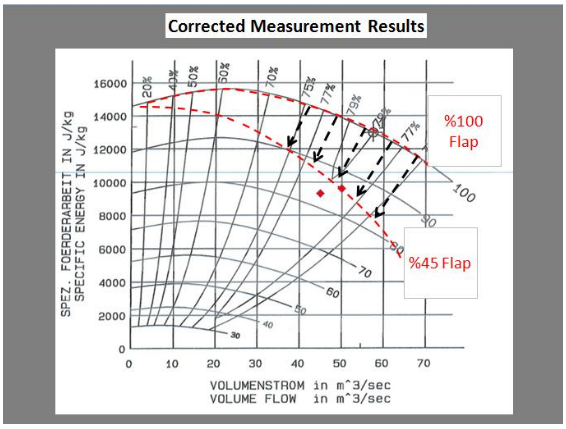
The average 45% damper aperture rate for the coal mill ID fan is shown in the above calculation, and in the feasibility calculation is assumed that the damper operates at an average of 45% aperture throughout the year.

Table 3 – Coal Mill ID Fan's Actual Average Damper Aperture

| Actual Situation | Damper Aperture |
|---|---|
| Average | % 45 |

## 4.3 Feasibility Calculations

The Coal Mill ID fan has an average damper aperture of 45% and the average decrease of the 45% damper aperture on the air flow rate provided by the fan is shown in the graph below.




Graph 4 - Average Decrease in Air Flow Rate by Fan of 45% Damper Aperture

The ID fan has a 12,3% decrease in the flow rate between the operation of 100% and the operation of 45% of the damper aperture. In the graph above, it is seen that the average flow rate of the fan is 87,7%

Energy saving is calculated when this part of the fan capacity is operated by the frequency driver instead of the inlet damper. ID Fan's damper worked at 100% and motor speed at 43,7 Hz. The fan motor was shown to draw an average of 607 kW of power during the 1 year running period. An average of 203 kWh of electricity can be saved per hour, assuming that the power consumption is 810 kW when the capacity is reduced with the inlet damper.

In the ID fan controlled by the adjustment of the inlet damper with automation, the frequency driver to be applied to the fan will be replaced by the frequency driver which will be applied to the fan provides 100% damper aperture and the process needs will be adjusted with the frequency driver and a total electricity saving of 1.607.760 kWh will be provided.

Table 4 – Saving Calculation

| **Saving Calculation** | **ID Fan** | **Unit** |
|---|---|---|
| **Energy Consumption Quantities in the Current Situation** | | |
| **Annual Energy Consumption** | 6.415.200 | kWh/year |
| **Hourly Average Energy Consumption** | 810 | kWh |
| **Energy Consumption Quantities After Frequency Driver Application** | | |
| **Annual Energy Consumption** | 4.807.440 | kWh/year |
| **Hourly Average Energy Consumption** | 607 | kWh |
| **Amount of Saving** | | |
| **Annual Working Time** | 7.920 | hour |
| **Total Savings** | 1.607.760 | kWh/year |
| **Energy Unit Price** | 0,228675 | TL/kWh |
| **Saving Amount** | 367.655 | TL/year |

## 4.4 Verification of Feasibility After Implementation

The measurements made before and after the implementation of the frequency driver in the Coal Mill ID fan are given below.

Measurements before and after the implementation were made while the fan was in regime and the product was manufacturing. Flow Rate measurements were made from fan suction side. The values for the measurements made after the implementation are indicated in the table below.

Table 5- Energy Consumption Result Table

| **Feasibility Comparison Table** | **ID Fan** | **Unit** |
|---|---|---|
| **Before Implementation** | | |
| Total Energy Consumption (hourly) | **810** | **kWh** |
| Fan Flow Rate | **2.580** | **$m^3$/dk** |
| **Feasibility After Implementation (Target)** | | |
| Total Energy Consumption (hourly) | **607** | **kWh** |
| **Implementation Results** | | |
| Total Energy Consumption (hourly) | **598** | **kWh** |
| Fan Flow Rate | **2.580** | **$m^3$/dk** |

Table 6- Comparison of Results with Feasibility Calculation

| Comparison of Results with Feasibility Calculation | | | | |
|---|---|---|---|---|
| | **Calculation according to Feasibility Target** | | **Calculation according to implementation results** | |
| Total Energy Saving (Hourly) | **203** | **kWh** | **212** | **kWh** |
| Operation time | **7.920** | **Saat/yıl** | **7.920** | **Hour/year** |
| Saving Energy Amount | **1.607.760** | **kWh/yıl** | **1.679.040** | **kWh/year** |
| Energy Unit Price | **0,228675** | **TL/kWh** | **0,228675** | **TL/kWh** |
| Saving Amount | **367.655** | **TL/yıl** | **383.954** | **TL/year** |

The energy consumption of the system before implementation was measured at 810 kWh and was aimed reducing energy consumption to 607 kWh at the same mass flow rate after implementation. After the implementation, the actual consumption of the measurement was 598 kWh and the feasibility prediction was provided and the theoretical and actual results were verified.

## 5. Evaluation and Conclusion

In the calculations and measurements made before and after the implementation, the energy consumption of the fan is reduced and energy saving obtained.

When the implementation was made with the inlet damper before the implementation, the power taken was measured to be 810 kW and after implementation, the consumption decreased to 607 kWh when the variable speed driver was provided. The resulting energy savings of 598 kWh are calculated as a result. With this energy efficiency application, 928.609 kg $CO_2$ emission per year is prevented.

Picture 2- Variable Speed Driver- Medium Voltage (Sinamics Perfect Harmony - GH180)

With this implementation, which is in the coal mill ID fan, the energy consumption decreased as 26%.

**Learn more:**
**www.siemens.com.tr/eos**

**Siemens Turkey Digital Factory**

Yakacık St. No: 111 34870 Kartal
İstanbul / Turkey

E-posta:
mert.kalpar@siemens.com

Call Center: 444 0 747



Follow us on:
twitter.com/SiemensTurkiye
youtube.com/SiemensTurkiye
instagram.com/siemensturkiye