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Increasing Energy Efficiency In Primary Air, Secondary Air And Induced Draft Fans From Internal Consumption Reduction Precautions In Energy Power Plants

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1. Summary

In recent years, climate change has become an important issue for our country and the world. The goal of reducing carbon dioxide emissions and increasing energy demand requires efficient use of energy resources. One of the most important precaution is reducing emissions, causes increase in energy efficiency both on the consumption and the production side.While electrical energy is produced in thermal power plants, equipment used in process also consumes energy and creates internal consumption. Electricity consumed in the internal needs of plant, directly affects energy production costs. In this manner, energy efficiency applications to reduce internal energy consumption of thermal power plants, helps to reduce energy production costs, emission values and efficient use of energy resources.

In this work made for the stated purposes, boiler combustion air fans (Primary Air, Secondary Air) and Induced Draft fans in thermal power plants were examined in terms of energy efficiency. In the work, the average energy savings obtained by using the variable speed driver in the fan controlled damper in the thermal power plant boilers are given.In the case of primary air, secondary air, and induced draft fan controlled by a damper in a sample plant, the amount of savings obtained and the period of repayment given with the before application measurements and calculations, as well as the consumption after the application are specified.

Key Words: Energy Efficiency, Thermal Power Plant, Fans, Variable Speed Driver

2. Purpose and Scope of the Work

This example examines energy savings in the primary fans that supply primary air from steam boilers to different units in the power plants at more than 100 MW power, the secondary fans and the ID fans that transfer the combustion gases. In the scope of the work, the measurements were made on the fans and the work data records were taken from the plant . The amount of savings to be achieved is calculated and detailed.

These fans were found to be operating conditions that varied according to process requirements and were set by means of dampers 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 work is to achieve the desired flow rate, which is proportional to the engine speed, since the flow rate adjustment is achieved with a variable speed driver to be connected to the electric motor, which saves considerable amounts of energy consumption.

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 drops. So, fan efficiency is kept at the highest possible level at varying flow rates.

The issue of providing variable flow rate demand with variable speed drivers is one of the most common electrical energy saving methods in today's systems driven by engines.

4. Variable Speed Driver Application in Primary Air Fans

4.1. Existing Status and Measurements

The primary fans send primary air to the boiler to provide fuel burning. Many plants are adjusting the flow rate control of the fans with the ineffective dampers(i.e. dampers cause ineffectiveness). Although this method seems to has less investment cost, considerable amount of energy lost during the period of production in the plant.

Table 1 - Measurements for Primary Air Fans

Measurement and Calculation Results Primary Air Fans	PA FAN A	PA FAN B	Unit
Inlet Damper Aperture %			
Maximum Capacity	68	69	%
Average Capacity	58	59	%
Minimum Capacity	46	47	%
Total Air Flow Rate (Boiler Inlet)			
Maximum Capacity	324.919		Nm^3/h
Average Capacity	312.247		Nm^3/h
Minimum Capacity	240.856		Nm^3/h
Amount of Energy Consumptions			
Annual Energy Consumption	10.663.488	10.558.944	kWh/year
Hourly Average Energy Consumption	1.346	1.333	kWh
Amount of Energy Consumed by Fans After Throttle with Inlet Damper			
Maximum Capacity	1.390	1.378	kWh
Average Capacity	1.346	1.333	kWh
Minimum Capacity	1.274	1.193	kWh

Primary air supply fan dampers, at working plant, are proportionally adjusted by the automation system according to the amount of fuel given to the boiler. The results of the flow rate and energy consumption measurements made in Primary Air Fan A and B are given in detail in the table above.

The rate of change of power according to Affinity law is proportional to cube of the change in flow rate. Inspection of the supply fans in the system seems to be an inefficient method in terms of energy efficiency of the automation controlled damper.

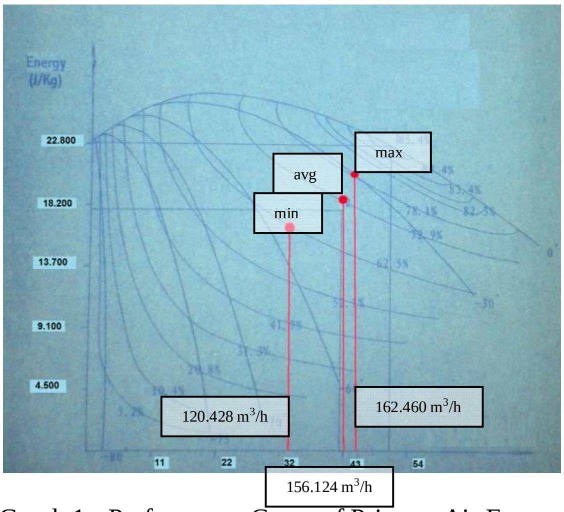
Table 2 - Calculation of Decrease in Energy Consumption in Different Damper Apertures

Total Air Flow Rate (Boiler Inlet)				**Change in Air Flow Rate**
Maximum Capacity	324.919		Nm^3/h	
Average Capacity	312.247		Nm^3/h	-%25,9
Minimum Capacity	240.856		Nm^3/h	
Amount of Energy Consumed by Fans After Throttle with Inlet Damper				**Change in Energy Consumption**
Maximum Capacity	1.390	1.378	kWh	
Average Capacity	1.346	1.333	kWh	-%8,3
Minimum Capacity	1.274	1.193	kWh	-%13,4

The table above, prepared with reference to plant data, shows the total decrease in power consumption of the due to the decrease in flow rate. When the table was examined, the primary air entering the boiler was reduced by 25,9% when the plant was reduced from the maximum production power to minimum production power, while the total power consumed by the fans was an average of 11% for the same flow rate reduction. If this flow rate reduction was obtained with variable speed driver applied to the fan motor instead of mechanical damper, the total power consumed by the fans would be much less.

4.2. Feasibility Calculations

It is known that the power plant unit operates at an average annual power and it can be seen at Scada system. The average system capacity of the automation system is determined and the energy consumption due to the adjustment of the fan speed ,using the variable speed driver instead of the reduction with the damper for the required air flow rate at the average system capacity in Primary Air Fan A and B, is calculated below.



Graph 1 - Performance Curve of Primary Air Fan

When the performance curves of the primary air fans are examined, it is seen that each fan has an discharge capacity of 181.870 Nm^3/h under the current operating conditions. However, despite we reach maximum power capacity of the plant, totally 324.919 Nm^3/h flow rate is required. This shows that high-capacity fan is using, depending on needs.

The primary air fan's damper's aperture is 70%, while using the maximum power, and that the fan at 1.800 kW has only a power consumption of 1.390 kW, shows that fan is larger than the need. This increases the savings that will occur after using the variable speed driver.

After using the variable speed driver, the inlet damper will be fully opened (100%) and the desired flow rate will be provided by reducing the fan speed through the variable speed driver. As shown in the following table, when the inlet damper is fully open, system produces maximum power, the primary air fans are operate at 44,7 Hz frequency, while the power is average, fan is operate at 42,9 Hz frequency and the minimum power production comes with fan frequency 33,1 Hz.

Table 3 - Calculation of Energy Consumption After Variable Speed Driver

Calculation of Energy Consumption Decrease After Variable Speed Driver Implementation	**PA FAN A**	**PA FAN B**	**Unit**
Total Air Flow Rate (Boiler Inlet)			
Fan Maximum Capacity (Performance Curve)	181.870	181.870	**Nm^3/h**
Maximum Capacity	162.460	162.460	**Nm^3/h**
Average Capacity	156.124	156.124	**Nm^3/h**
Minimum Capacity	120.428	120.428	**Nm^3/h**
Fan Frequency Value After Driver Use			
Fan Maximum Capacity (Performance Curve)	50	50	**Hz**
Maximum Capacity	44,7	44,7	**Hz**
Average Capacity	42,9	42,9	**Hz**
Minimum Capacity	33,1	33,1	**Hz**
Power Consumption of Fans After Variable Speed Driver			
Maximum Capacity	1.286	1.275	**kWh**
Average Capacity	1.137	1.089	**kWh**
Minimum Capacity	522	489	**kWh**
Energy Consumption (with Variable Speed Driver)			
Annual Energy Consumption	9.004.499	8.624.850	**kWh/year**
Hourly Average Energy Consumption	1.137	1.089	**kWh**
Total Amount of Saving	3.587.760		**kWh/year**
Energy Unit Price	0,228694		**TL/kWh**
Annual Savings Amount	820.499		**TL/year**

If the capacity of the primary air fans is controlled by the variable speed driver while the damper is in the fully open position instead of the control by the damper, the amount of energy savings to be generated per year is calculated as 3.587.760 kWh.

4.3. Validation of Feasibility After Implementation

The measurements made before and after implementation of variable speed driver in primary air fans are given below. The measurements were made when the fan provided the same flow rate.

Table 4- Energy Consumption Result Table

Feasibility Comparison Table	**PA Fan A**	**PA Fan B**	**Unit**
Before Implementation Status			
Energy Consumption(Hourly)	**1.346**	**1.333**	**kWh**
Fan's Flow Rate	**156.124**	**156.124**	**Nm^3/h**
Feasibility After Implementation (Target)			
Energy Consumption(Hourly)	**1.137**	**1.089**	**kWh**
After Implementation (Results)			
Energy Consumption(Hourly)	**1.129**	**1.095**	**kWh**
Fan's Flow Rate	**156.124**	**156.124**	**Nm^3/h**

Table 5- Comparison of Results and Feasibility Calculations

	Calculation according to Feasibility Target		After Implementation Results	
Total Energy Saving(Hourly)	**453**	**kWh**	**455**	**kWh**
Operation Time	**7.920**	**Saat/year**	**7.920**	**Saat/year**
Saving Energy Amount	**3.587.760**	**kWh/year**	**3.603.600**	**kWh/year**
Energy Unit Price	**0,228694**	**TL/kWh**	**0,228694**	**TL/kWh**
Saving Amount	**820.499**	**TL/year**	**824.122**	**TL/year**

The total energy consumption of the fans before application was 2.679 kWh, but 2.226 kWh was aimed at the theoretical feasibility at the same flow rate after application. The total energy consumption measured after the application was 2.224 kWh. Savings of 455 kWh was achieved almost the same as calculated on feasibility.

4.4. Variable Speed Driver Application in Secondary Air Fans

4.5. Existing Status and Measurements

Secondary air fans send the fresh air to the boiler to complete the combustion. Many plants are adjusting the flow rate control of the fans with inefficient methods(dampers). Although this method is low as the investment cost, the overall cost is much higher than the work done.

Secondary air fans' flow rate are adjusted by the mechanical dampers on the suction lines. The fans are controlled by calculating the percentage of oxygen contained in the chimney gas.

The results of flow rate and energy consumption measurements made at Secondary Air Fan A and B are detailed below.

Table 6- Measurement and Calculations

Measurement and Calculation Results (Primer Air Fans)	**SA FAN A**	**SA FAN B**	**Unit**
Inlet Damper Aperture %			
Maximum Capacity	23	23	**%**
Average Capacity	15	15	**%**
Minimum Capacity	12	12	**%**
Total Air Flow Rate (Boiler Inlet)			
Maximum Capacity	106.270		**Nm^3/h**
Average Capacity	71.234		**Nm^3/h**
Minimum Capacity	59.998		**Nm^3/h**
Amount of Energy Consumptions			
Annual Energy Consumption	4.062.960	3.920.400	**kWh/ year**
Hourly Average Energy Consumption	513	495	**kWh**
Amount of Energy Consumed by Fans After Throttle with Inlet Damper			
Maximum Capacity	563	578	**kWh**
Average Capacity	513	495	**kWh**
Minimum Capacity	442	438	**kWh**

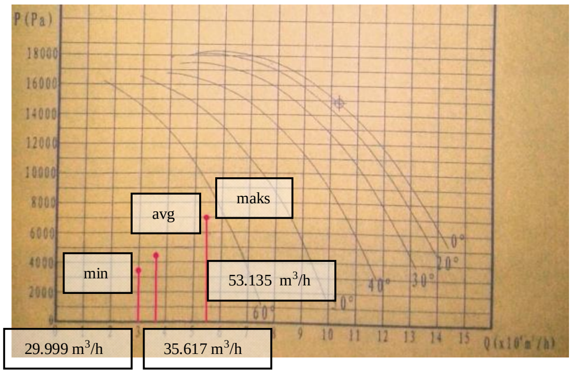
The rate of change of power according to Affinity law is proportional to cube of the change in flow rate. Inspection of the secondary fans in the system seems to be an inefficient method in terms of energy efficiency of the automation controlled damper.The table below shows the ratio of the decrease in the flow rate to the total decrease in power consumed by the fan. From table the secondary air, entering the boiler, flow rate decreased 43,5% when the production power of the plant decreases from maximum to minimum, while the total power consumption of the fans was 22,8% on average for the same decrease. The total power consumed by the fans would be much less if the flow throttling was made with variable speed driver applied to the fan motor instead of mechanical damper.

Table 7- Change in Flow Rate and Energy Consumption

Total Air Flow Rate (Boiler Inlet)				Change in Air Flow Rate
Maximum Capacity	106.270		Nm^3/h	-%43,5
Average Capacity	71.234		Nm^3/h	
Minimum Capacity	59.998		Nm^3/h	
Amount of Energy Consumed by Fans After Throttle with Inlet Damper				**Change in Energy Consumption**
Maximum Capacity	563	578	kWh	-%21,4 -%24,2
Average Capacity	513	495	kWh	
Minimum Capacity	442	438	kWh	

4.6. Feasibility Calculations

It is known that the power plant is operated at an average annual power during the year. For this reason, the average system capacity of the automation system is determined and the energy consumption ,due to the adjustment of the fan speed by using variable speed driver instead of throttling by the damper for the required air flow during working the Secondary Air Fan A and B with an average system capacity, calculated below.



Graph 2 - Performance Curve of the Secondary Air Fan

When the performance curves of the secondary air fans are examined, it is seen that the fan has a capacity of 123.600 Nm^3/h in the current operating conditions. However, in the plant, although the unit power is maximum, 53.135 Nm^3/h is required. This suggests that they are working with a somewhat high-capacity fan, depending on needs.

After using the variable speed driver, the suction damper will be opened to 100% position and the desired flow rate will be provided by reducing the fan speed with the variable speed driver. As can be seen in the following table, when the damper is fully opened, secondary air fans operated at 45,1 Hz frequency while the unit produces maximum power, while the unit power is average, while the fan is operated at 30,2 Hz frequency and at the minimum power level, fan is driven at 25,4 Hz frequency.

Table 8 - Calculation of Energy Consumption After Variable Speed Driver

Calculation of Energy Consumption Decrease After Variable Speed Driver Implementation	SA FAN A	SA FAN B	Unit
Total Air Flow Rate (Boiler Inlet)			
Fan Maximum Capacity (Performance Curve)	123.600	123.600	Nm^3/h
Maximum Capacity	53.135	53.135	Nm^3/h
Average Capacity	35.617	35.617	Nm^3/h
Minimum Capacity	29.999	29.999	Nm^3/h
Fan Frequency Value After Driver Use			
Fan Maximum Capacity (Performance Curve)	50	50	Hz
Maximum Capacity	45,1	45,1	Hz
Average Capacity	30,2	30,2	Hz
Minimum Capacity	25,4	25,4	Hz
Power Consumption of Fans After Variable Speed Driver			
Maximum Capacity	270	281	kWh
Average Capacity	159	150	kWh
Minimum Capacity	119	118	kWh
Energy Consumption (with Variable Speed Driver)			
Annual Energy Consumption	1.259.280	1.188.000	kWh/year
Hourly Average Energy Consumption	159	150	kWh
Total Amount of Saving	5.536.080		kWh/year
Energy Unit Price	0,228694		TL/kWh
Annual Savings Amount	1.266.068		TL/year

The energy savings per year is calculated as 5.536.080 kWh if the capacity of the secondary air fans is adjusted by the variable speed driver instead of the control by the damper, according to the process requirements.

4.7. Validation of Feasibility After Implementation

The measurements made before and after the implementation of variable speed driver on the secondary fans are given below.

Measurements before and after the application were made when the fan provided the same air flow rate.

The values for the measurements made after the application are indicated in the table below.

Table 9- Energy Consumption Result Table

Feasibility Comparison Table	Secondary Air Fan A	Secondary Air Fan B	Unit
Before Implementation Status			
Energy Consumption(Hourly)	**513**	**495**	**kWh**
Fan's Flow Rate	**35.617**	**35.617**	**Nm³/h**
Feasibility After Implementation (Target)			
Energy Consumption(Hourly)	**159**	**150**	**kWh**
After Implementation (Results)			
Energy Consumption(Hourly)	**157**	**153**	**kWh**
Fan's Flow Rate	**35.617**	**35.617**	**Nm³/h**

Table 10- Comparison of Results and Feasibility Calculations

	Calculation according to Feasibility Target		After Implementation Results	
Total Energy Saving(Hourly)	**699**	**kWh**	**698**	**kWh**
Operation Time	**7.920**	**h/year**	**7.920**	**h/year**
Saving Energy Amount	**5.536.080**	**kWh/year**	**5.528.160**	**kWh/year**
Energy Unit Price	**0,228694**	**TL/kWh**	**0,228694**	**TL/kWh**
Saving Amount	**1.266.068**	**TL/year**	**1.264.257**	**TL/year**

The total energy consumption of the fans before the application was measured at 1.008 kWh and the theoretical feasibility calculation was aimed at reducing the energy consumption to 309 kWh at the same flow rate after application. The actual consumption after the application was 310 kWh. Approximately the same energy savings realized as the feasibility obtained.

5. Variable Speed Driver Implementation on ID (Induced Draft) Air Fans

5.1. Existing Status and Measurements

ID air fans direct the combustion gas resulting from the burning of the fuel in the steam boiler to the filtration system and chimney. Many plants adjust the flow rate control of the fans with the ineffective methods(dampers). Although this method is low as the investment cost, the overall cost is much higher than the work done.

The ID fans we are working on are operated in an automation controlled to provide the boiler internal pressure. The results of the flow rate and energy consumption measurements made at ID Air Fan A and B are detailed in the table below.

Table 11 - Calculations for ID Air Fans

Measurement and Calculation Results (ID Air Fans)	ID FAN A	ID FAN B	Unit
Inlet Damper Aperture %			
Maximum Capacity	42	42	**%**
Average Capacity	35	35	**%**
Minimum Capacity	28	28	**%**
Total Air Flow Rate (Boiler Inlet)			
Maximum Capacity	720.000		**Nm³/h**
Average Capacity	674.400		**Nm³/h**
Minimum Capacity	613.800		**Nm³/h**
Amount of Energy Consumptions			
Annual Energy Consumption	7.492.320	7.397.280	**kWh/year**
Hourly Average Energy Consumption	946	934	**kWh**
Amount of Energy Consumed by Fans After Throttle with Inlet Damper			
Maximum Capacity	1.026	1.025	**kWh**
Average Capacity	946	934	**kWh**
Minimum Capacity	898	875	**kWh**

The rate of change of power according to Affinity law is proportional to cube of the change in flow rate. Inspection of the ID fans in the system seems to be an inefficient method in terms of energy efficiency of the automation controlled damper.

Table 12 – Calculation of the Energy Consumption in Different Damper Apertures

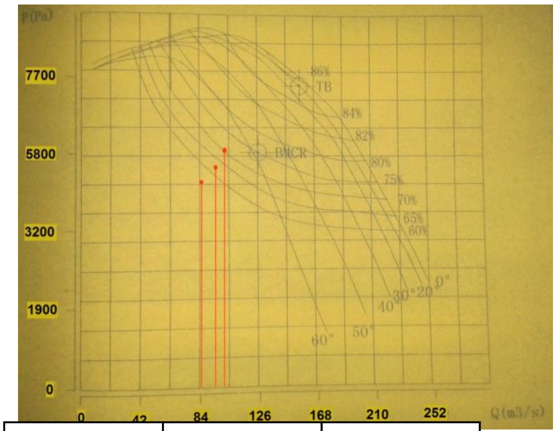
Total Air Flow Rate (Boiler Inlet)				**Change in Air Flow Rate**
Maximum Capacity	720.000		**Nm³/h**	
Average Capacity	674.400		**Nm³/h**	**-%14,8**
Minimum Capacity	613.800		**Nm³/h**	
Amount of Energy Consumed by Fans After Throttle with Inlet Damper				**Change in Energy Consumption**
Maximum Capacity	1.026	1.025	**kWh**	
Average Capacity	946	934	**kWh**	**-%12,5** **-%14,6**
Minimum Capacity	898	875	**kWh**	

5.2. Feasibility Calculations

The table above, prepared with reference to plant data, shows the total decrease in power consumption of the due to the decrease in flow rate.

When the table is examined, the combustion gas is reduced by 14.8% when the power plant is reduced from maximum production power to minimum, while the total power consumed by the fans is decreased 13,5% on average. If this flow rate throttle was made with variable speed driver applied to the fan motor instead of mechanical damper, the total power consumed by the fans would be much less.

The average system capacity for the data was calculated from the scada system and the energy consumption due to the adjustment of the fan speed using the variable speed driver instead of throttle with the damper for the required gas flow rate during the operation in the ID Fan A and B with an average system capacity.



306.900 m^3/h	337.200 m^3/h	360.000 m^3/h

Graph 3 - ID Air Fan Performance Curve

When the performance curves of the ID air fans are examined, it is seen that each fan has an air discharge capacity of 567.000 Nm^3/h under the current operating conditions. However, even though the unit power is maximum at plant, it seems that 360.000 Nm^3/h air flow rate is required. This suggests that you are working with a high-capacity fan, depending on needs.

After using the variable speed driver, the suction damper will be opened to 100% position and the desired flow rate will be provided by reducing the fan speed with the variable speed driver. As can be seen in the following table, when the damper is fully opened, ID fans operated at 38,1 Hz frequency while the unit produces maximum power, while the unit average power, the fan is operated at 35,7 Hz frequency and at the minimum power level, fan is driven at 32,5 Hz frequency.

Tablo 13 – Calculation of Energy Consumption After Variable Speed Driver

Calculation of Energy Consumption Decrease After Variable Speed Driver Implementation	**ID FAN A**	**ID FAN B**	**Birim**
Total Air Flow Rate (Boiler Inlet)			
Fan Maximum Capacity (Performance Curve)	567.000	567.000	**Nm^3/h**
Maximum Capacity	360.000	360.000	**Nm^3/h**
Average Capacity	337.200	337.200	**Nm^3/h**
Minimum Capacity	306.900	306.900	**Nm^3/h**
Fan Frequency Value After Driver Use			
Fan Maximum Capacity (Performance Curve)	50	50	**Hz**
Maximum Capacity	38,1	38,1	**Hz**
Average Capacity	35,7	35,7	**Hz**
Minimum Capacity	32,5	32,5	**Hz**
Power Consumption of Fans After Variable Speed Driver			
Maximum Capacity	525	531	**kWh**
Average Capacity	454	471	**kWh**
Minimum Capacity	301	301	**kWh**
Energy Consumption (with Variable Speed Driver)			
Annual Energy Consumption	3.595.680	3.730.320	**kWh/year**
Hourly Average Energy Consumption	454	471	**kWh**
Total Amount of Saving	7.563.600		**kWh/year**
Energy Unit Price	0,228694		**TL/kWh**
Annual Savings Amount	1.729.750		**TL/year**

The energy savings per year is calculated as 7.563.600 kWh if the capacity of the ID air fans is adjusted by the variable speed driver instead of the control by the damper, according to the process requirements.

5.3. Validation of Feasibility After Implementation

The measurements made before and after the implementation of variable speed driver on the ID fans are given below.

Measurements before and after the application were made when the fan provided the same air flow rate. The values for the measurements made after the application are indicated in the table below.

Table 14- Energy Consumption Result Table

Feasibility Comparison Table	ID Fan A	ID Fan B	Birim
Before Implementation Status			
Energy Consumption(Hourly)	**946**	**934**	**kWh**
Fan's Flow Rate	**337.200**	**337.200**	**Nm^3/h**
Feasibility After Implementation (Target)			
Energy Consumption(Hourly)	**454**	**471**	**kWh**
After Implementation (Results)			
Energy Consumption(Hourly)	**451**	**465**	**kWh**
Fan's Flow Rate	**337.200**	**337.200**	**Nm^3/h**

Table 15- Comparison of Results and Feasibility Calculations

	Calculation according to Feasibility Target		**After Implementation Results**	
Total Energy Saving(Hourly)	**955**	**kWh**	**964**	**kWh**
Operation Time	**7.920**	**h/year**	**7.920**	**h/year**
Saving Energy Amount	**7.563.600**	**kWh/year**	**7.634.880**	**kWh/year**
Energy Unit Price	**0,228694**	**TL/kWh**	**0,228694**	**TL/kWh**
Saving Amount	**1.729.750**	**TL/year**	**1.746.051**	**TL/year**

The total energy consumption of the fans before the implementation was measured at 1.880 kWh and the theoretical feasibility calculation was aimed at reducing the energy consumption to 925 kWh at the same flow rate after implementation. Consumption after the implementation was 916 kWh. Savings were achieved almost the same as the feasibility.

6. Evaluation and Conclusion

As a result of the calculations made, it can be seen in the table below that the amount of the result can be saved by providing the variable variable speed driver instead of the damper which is the inefficient control method of the fans.

Table 16- After Implementation Consumption Values, Saving Amounts and Environmental Impacts

Result	Primary Fans	Secondary Fans	ID Fans	Unit
Current state				
Total Annual Energy Consumption	21.217.680	7.983.360	14.889.600	kWh/year
Total Hourly Average Energy Consumption	2.679	1.008	1.880	kWh
Status After Variable Speed Drive Implementation				
Total Hourly Average Energy Consumption	2.226	310	916	kWh
Total Hourly Energy Saving Amount	455	698	964	kWh
Total Annual Energy Savings	3.603.600	5.528.160	7.634.880	kWh/year
Total Annual Savings Amount	824.122	1.264.257	1.746.051	TL/year
CO_2 Reduction	1.993.005	3.057.402	4.222.543	kg/year

Before application throttling in the Primary fans was done with the inlet damper, the energy consumption was measured to be 2.679 kWh and the consumption decreased to 2.226 kWh when the reduction operation was provided with variable speed driver after application. The resulting energy savings of 455 kWh are calculated as a result.

Picture 1- Medium Voltage Variable Speed Driver (Sınamıcs Perfect Harmony - GH180)

Before application throttling in the Secondary fans was done with the inlet damper, the energy consumption was measured to be 1.008 kWh and the consumption decreased to 310 kWh when the reduction operation was provided with variable speed driver after application. The resulting energy savings of 698 kWh are calculated as a result.

Before application throttling in the ID fans was done with the inlet damper, the energy consumption was measured to be 1.880 kWh and the consumption decreased to 916 kWh when the reduction operation was provided with variable speed driver after application. The resulting energy savings of 964 kWh are calculated as a result.

In addition, with the these energy efficiency opportunities, a total of 9.273 tons of CO_2 emissions were prevented per year.

While electrical energy is produced in thermal power plants, equipment used in process also consumes energy and generates internal consumption. Electricity consumed in plant internal needs directly affects the energy production costs, and the energy savings of 2.117 kWh with an energy efficiency increase can be obtained in primary air fans, secondary air fans and ID fans in a power plant.

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