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Energy Efficiency In Hot Rolling Mill Plant's Descale Pumps

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1. Summary

In the steel production sector, which has an energy intensive process, the share of energy costs in total cost is second after raw material and is in the range of 15-25%. For this reason, reducing the cost of products and increasing competition power in the market, the importance of energy efficiency increases day by day in the Iron and Steel Sector.

In this work descale pumps in the sheet metal hot rolling plants which cause intensive energy consumption have been examined in terms of energy efficiency. In steel production process descaling is applying. In this process, high pressure water is sprayed with descale pumps. In traditional applications, descale pumps continue to operate at the same speed when there is no material to be cleaned in the band, and the water delivered by the pump returns to the pool by the bypass line. In this case, pumps do not work beneficial and cause unnecessary energy consumption. By this work, energy saving amounts for descale pumps which can be obtained by decreasing the speed with variable speed driver are given when there is no material on the band. The descale pumps controlled by traditional methods (bypass line) were examined for a sample plant and necessary measurements were made. Energy saving is achieved by reducing the pump revolution by applying a variable speed driver to descale pumps, which cause unnecessary energy consumption when there is no material on the band. In this work, the measurements and calculations made before implementation and the measurements made after implementation are given in detail and the amount of savings obtained is indicated.

Key Words: Iron and Steel, Sheet Metal Rolling Plant, Energy Efficiency, Descale Pump, Variable Speed Driver.

2. Purpose and Scope of the Work

The purpose of this work is to examine the effectiveness of applying a variable speed drive to increase energy efficiency in descale pumps cleaning the surface by spraying high pressure water onto hot slab materials from the slab furnace.

In the descale pump examined, energy consumption measurements were made for 1 hour while producing the product in the sheet metal rolling plant and the number of hot slabs coming out of the slab furnace, i.e. the number of slabs cleaned by the descale pumps, was counted. The descale pumps used to clean the scale residues on the surface of the hot slab, which is came from the slab furnace, spray the high pressure water onto the slab surface when the hot slab came into the area called descaler. After the slab leaves the descaler, the pumps stop spraying and the pump continues to run idle, providing minimum flow in bypass. It is intended to reduce the energy consumption during idle operation of this pump which is spraying for a short period of time within the total working time and is idle for the remaining long time period.

3. Energy Efficiency in Steel Production Sector

According to TSMA (Turkish Steel Manufacturers Association) in 2016, Turkey is the second largest steel producer in Europe with 33.2 million tons of crude steel production and the eighth largest steel producer in the world.

This sector, which has such a large production capacity, aims slabs and logs obtained by using blast furnaces or arc furnaces reach the desired physical and chemical properties after processing. Energy costs in this sector are second among all costs, and electricity consumption in integrated plants can reach up to 65% of all energy consumption. This rate shows how important energy is in the iron and steel industry

Energy saving measures and energy investments are very important in order to reduce production costs and increase competition power in international markets. In order to increase the energy saving in this work, it is aimed to increase the efficiency of the descale pump used in the

sector and to determine the energy savings obtained after the implementation.

4. Implementation of Variable Speed Drive in Sheet Metal Hot Rolling Plant Descale Pumps

4.1 Current State

When the product which needs to be cleaned reaches the Descale pumps, it sprays the water on the surface with high pressure and works idle during the remaining working time. Pumps are special pumps with medium voltage motors 10,0 kV and pumps are stopped and need to be restarted when there is no need for spraying is not recommended because it happens very frequently.

The aim of the work is to reduce the energy consumption during idle operation by ensuring that the descale pump, which works loaded during the spraying operation and continues to idle during the non-spraying period, operates at low speed in idle mode.

4.2 Measurement Results

Measurements were made in the descale pump in the sheet metal rolling plant before implementation. Measurements were made for 1 hour while the descale pumps are in regime and the product was producing at the sheet metal rolling plant .

1 slab surfaces was cleaned in 4 minutes. The measurement time was determined to be 1 hour because the amount was sufficient to measure average energy consumption. The measuring operation on the descale pump was carried out with the energy analyzer for 1 hour and the number of slab surfaces cleaned in this time zone where production is continuous is counted.

Table 1-Descale Pump Measurement Results

Measurement Results	Value	Unit
Descale Pump Hourly Energy Consumption	2.709,8	**kWh**
Total Working Duration of Descale Pump for 1 Slab Surface Cleaning	240	**Second**
Descale Pump's Water Spraying Time for 1 Slab Surface Cleaning	110	**Second**
Pump's Idle Operation Time for 1 Slab Surface Cleaning	130	**Second**

It is seen that the descale pump examined in the above measurements runs for 240 seconds for each slab surface cleaning operation and the pump runs idle for 130 seconds of this time.

Table 2- Descale Pump's Idle and Loaded Measurement Results Before Implementation

Measurement Results	Value	Unit
Descale Pump Hourly Energy Consumption	2.709,80	**kW**
Avarage Power Consumption During Loaded Operation	3.176,90	**kW**
Avarage Power Consumption During Idle Operation	2.314,56	**kW**

When the measurement results are examined, it will be seen that energy consumption during loaded operation is higher than energy consumption during idle operation. This is due to the fact that the energy consumption of the pump is also proportional to the volume of water sprayed onto the slab surface during operation. In the idle position, the pump passes through the bypass and reduces the flow rate to a minimum.

Measurements were also carried out after the implementation, in which same amount of slabs were cleaned in 1 hour. When the data is evaluated before and after the implementation, the number of slab passing through the descaler area is important.

4.3 Feasibility Calculations

Since the Descale pump does not have a variable speed drive in the current situation, it is operating with 50 Hz frequency at full speed while loaded and idle operations. However, even when the pump is not spraying, it consumes an average of 2.314,56 kW power.

The goal of the efficiency project is to reduce energy consumption by operating the descale pump at low speed in idle mode. For this purpose, the idle operation of the descale pump, which is in idle mode for a considerable part of the annual operating time, is operated by reducing the speed to 19 Hz frequency with the variable speed drive.

The characteristic curves given by the pump manufacturer and the minimum flow limit values have been evaluated and it has been found technically inappropriate for the pump to fall below the frequency of 19 Hz and therefore the speed of the pump is determined to be 19 Hz frequency during idling period.

During loaded operation, the 50 Hz frequency operation will continue as in the current situation and the drive frequency will increase from 19 Hz to 50 Hz when the idle pump is loaded. If the pump is idle again, the pump operating at 50 Hz frequency will fall to the frequency of 19 Hz and this frequency will operate during idling.

Table 3 Status Before Implementation

Status Before Implementation	Value	Unit
Descale Pump Hourly Energy Consumption	2.709,80	**kW**
Avarage Power Consumption During Loaded Operation	3.176,90	**kW**
Loaded Operation Frequency	50	**Hz**
Avarage Power Consumption During Idle Operation	2.314,56	**kW**
Idle Operation Frequency	50	**Hz**

After application, the loaded operation frequency will remain the same (50 Hz), but the idle operation frequency will be 19 Hz and considerable energy savings will be achieved. As the variable speed drive, which adds additional energy consumption to the system, is installed after running for duty, the energy consumption during loaded operation will increase by 1% (drive loss). The results after the calculations made using Affinity law are as follows.

The number of slabs going through the descaler after application will be the same, so how much idle and loaded operation will occur at 1 hour run time is calculated below.

Table 4 – Calculation of Savings

Calculation of Savings	Descale Pump	Unit
Energy Consumption Quantities in the Current Situation		
Annual Energy Consumption	21.461.616	kWh/year
Hourly Average Energy Consumption	2.709,8	kWh
Energy Consumption Quantities After Frequency Drive Application		
Annual Energy Consumption	12.694.977	kWh/year
Hourly Average Energy Consumption	1.602,9	kWh
Amount of Saving		
Annual Working Time	7.920	Hour
Total Savings	8.766.639	kWh/year
Energy Unit Price	0,228675	TL/kWh
Saving Amount	2.004.711	TL/year

As a result of the calculations, the variable speed drive to be applied in the descale pump was found to have an average energy consumption of 1.602,9 kWh per 1 hour of operation.

4.4 Comparison of After Implementation Situation

In the Descale Pump, measurements made before and after application related to frequency driver application are given below. These measurements were made while the pump was in regime and production was manufacturing .

Table 5- Energy Consumption Result Table

Feasibility Comparison Table	Descale Pump	Unit
Before Implementation Status		
Total Energy Consumption (hourly)	**2.709,8**	**kWh**
Feasibility After Implementation(Target)		
Total Energy Consumption (hourly)	**1.602,9**	**kWh**
Application Results		
Total Energy Consumption (hourly)	**1.591,3**	**kWh**

Table 6- Comparison of Feasibility and Results

Comparison of Feasibility and Results				
	Calculation According to Feasibility Target		**Calculation According to Results(After Implementation)**	
Total Energy Saving (Hourly)	1.106,90	kWh	1.118,50	kWh
Operation time	7.920	Hour/Year	7.920	Hour/Year
Saving Energy Amount	8.766.639	kWh/year	8.858.520	kWh/year
Energy Unit Price	0,228675	TL/kWh	0,228675	TL/kWh
Saving Amount	2.004.711	TL/year	2.025.722	TL/year

The energy consumption of the system before implementation was measured to be 2.709,8 kWh and it was targeted in the theoretical feasibility calculation that the energy consumption after implementation would be reduced to 1.602,9 kWh. After the implementation, the actual consumption was 1.591,3 kWh and the feasibility was ensured and the theoretical and actual results were verified.

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

5. Evaluation and Conclusion

In the measurements made after the implementation, the energy consumption of the descale pump is reduced and considerably energy saving obtained.

The energy consumption of the pump, which was operated by bypassing without cleaning before implementation, was measured as 2.709,8 kW and the consumption was decreased to 1.591,3 kWh by reducing the pump speed with the variable speed drive at times without surface cleaning instead of bypassing after implementation. For measurements after implementation, the savings were measured as %41. In addition, with this energy efficiency application, 4.900 tons CO_2 emissions per year are prevented.

The information provided in this brochure contains merely general descriptions or characteristics of performance which in case of actual use do not always apply as described or which may change as a result of further development of the products. An obligation to provide the respective characteristics shall only exist if expressly agreed in the terms of contract.

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