Productivity Improvement by Synchronization between Wire Rolling Machines

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Abstract – *Wire Rolling Machines are used to perform flattening & forming operation on wire which is used to produce product collet by bending & cutting operation on formed wire. Collets are used for engine valves in automobile each valve need two collet therefore demand is high providing collet to automobile industries. To satisfy customer demand production should increase which can be done by finding out areas for improvement through whole process. In earlier stage both wire rolling machines were operated separately while one machine was ON other machine was OFF & reverse there was no synchronization between two machine which leads to took more time to perform both operation which leads to lower the productivity. To overcome this problem we synchronized this two rolling machines by using VFD controller & installing Synchronization unit between two rolling machines in order to perform both operation safely & properly*

Key Words: **WRM, Dancer, VFD, Press Roller, Idler Pulley, Collets, Bobbin**

1.INTRODUCTION

The principal object of this project is to synchronization between two wire rolling machine in order to improve Productivity. Rolling is technical process of transforming the cross section of a feed stock that passes through set of rotationally symmetric tools called as Rolls. Rolling Process is classified as cold rolling, warm & hot rolling of wire or sheet. This project relates to cold rolling of flat & shaped wires.

Two separate wire rolling machines are used to perform flattening & forming operation. Wire from Payoff units to rolling tools. Pass through various system such as straighteners, cleaning system, calibration system, lubrication and cooling system and finally get wound on coiler unit/bobbin this flattened wire. Then further supplied to second wire rolling machine which is used to perform shaping/forming operation. Forming operation done/performed in two stages. Wire get wound on bobbin & coiled wire then goes to collet department where bending & cutting operation are performed on wire to get final product collet.

As both machine are run by different due to this reason both machine operation could not get performed simultaneously, while one machine running second machine was off and contrast. In order to improve productivity or to increase production synchronization had to be between two machine which is done by VFD controller which is installed on second machine and by designing and fabrication and installation of synchronization unit between two rolling machine for safety purpose.

2. OBJECTIVES:

The main objective of this project is to improve productivity by synchronization between two rolling machine which is done by VFD controller. And design & fabrication of synchronization unit & installation of this unit between two machines in order to maintain proper flow of stack between machine and for proper & safety operation.

3.COMPONENTS:

Vertical coil payoff, Straightener, Cleaning system, Calibration system, Guiding system, Synchronization unit, Inline measuring system(manually),Lubrication and cooling system, Electric control.

3.1. Vertical coil payoff –

The payoff machinery marks the start of a rolling mill line The function of the payoff is to accommodate the inlet wire in whatever way it is provided.

3.2. Straighteners-

Raw wires are usually paid off in a wound state necessitating a straightening process to receive straight wires after passing the mill's rolling machines. To reduce this risk, the straightening rolls are usually adapted to the wire shape by profiling the grooves on the rolls.

3.3. Cleaning system-

In rolling mills wire cleaning is typically applied to the inlet wire before rolling and to the finished wire before winding.. Cleaning of the finished wire is necessary to keep the rolling machine lubricant inside the machine instead of carrying it out.

3.4. Calibration system-

Wire guiding is often underrated. At the positions where the wire enters and exits the roll gap, guides help to: minimize dimensional variations because wire vibrations are damped.

3.5 Lubricating and Cooling System-

In rolling machines the coolant serves two purposes: wear protection and cooling.

Wear Protection-With regard to wear reduction, the function of the coolant is to separate metallic surfaces by building a lubricating film between them. This film has to withstand the rolling force and high local temperatures. The quality of the lubrication film also affects the quality (degree of roughness) of the wire surface.

Cooling- Without cooling, especially in multi-stand lines, the wire temperature would rise stand by stand. The result would be a loss of quality with regard to dimensional accuracy To minimize wear and to cool the rolls, the coolant is sprayed into the contact zones between wires and rolls. For efficient wire cooling between stands modern rolling machines come with cooling zones such as flooded dancer control basins .The lubricant is contained in a tank for each rolling machine or a central tank to serve multiple lines. The tank is connected with piping, and the flow pump and return pump control the coolant cycle.

3.5 Synchronization Units-

Rolling mills incorporate numerous electrically driven units that are involved in transporting the wire, such as payoffs, rolling machines, capstans, and spoolers. Due to wire elongation during rolling or drawing the material's speed increases when it passes the mill. The inlet wire is moving slower than the outlet wire. Moreover the drives of payoffs and spoolers have to adapt to the actual coil diameters for unwinding and winding the wire with proper tension. In a multi-stand rolling machine, usually the last driven rolling machine or the last capstan is the speed master for the line. The speed of the other driven machines—also referred to a slaves—is synchronized to this speed master by means of dancers or tension control units.

Dancer Control. Dancers are able to accumulate a certain volume of wire by means of one or more moveable deflection rolls if the speed of the slave is too slow or too fast. The term "dancer" is used for these systems because of the motions of the moveable roll. By preloading the deflection rolls by weight, spring, or a pneumatic cylinder, the wire is always tied. Moreover the wire tension can be adjusted by changing the preload. If the slave's speed is too slow or too fast, this will increase or decrease the amount of wire stored in the dancer and the moveable dancer roll will indicate this asynchrony between the speed of the master and slave by leaving its neutral position. By means of a sensor, which forwards the position of the moveable roll to the electrical drive control, the speed difference is detected and compensated by the control system until the moveable roll has returned to its neutral position. Due to the increased dynamics of today's control systems these movements are almost invisible in state-of-the-art rolling machines.

4. METHODOLOGY:

wire rolling machines have various components wire gets formed by passing through various system from coiled round wire to final formed shaped wire .process starts with loading wire in payoff units which supports and hold coiled wire this wire pass to straighteners which helps in straightening wire then wire passes to first rolling machine through cleaning system wire get flattened here and get coiled on coiler this coiled wire then store to storage. for forming operation stored wire from storage loaded on coiler this flattened wire passes to forming machine through guideways where forging operation done on wire and this get wound on coiler then this wire get unloaded and loaded again on first coiler and feed to forming machine for final pass. After that wire get wounded on coiler this coiled wire then passes to collet department where bending and cutting operation are done on wire to form final product collet.

As cutting speed of both rollers are different synchronization is not possible in order to increase production we had to synchronize two machine that we achieved by making speed of both rollers same which is by increasing frequency of motor by VFD which is installed on second machine

Specification:

1. **Flattening Machine:**

   Motor Capacity: 11 kW

   Motor Speed: 1460 rpm

   Output Shaft Speed: 88 rpm

   Diameter of Press Roller: 150 mm

   Gear Ratio: 1:15

   No. of Poles Motor: 4

2. **Forming Machine:**

   Motor Capacity: 7.5 kW

   Motor Speed: 2910 rpm

   Output Shaft Speed: 1230rpm

   Diameter of Press Roller: 100 mm

   Gear Ratio: 1:15

   No. of Poles Motor: 2

VFD:

VFD stands for variable feed drive. It has function of control the speed of machine. If we increases the frequency of VFD the speed of machine also increases & vice versa. On forming machine or machine 2 is also install a VFD. VFD is an electronic device which require programming for doing operation.

If we will increase the output speed i.e. V_2 upto V_1 i.e. from 0.6437 m/s to 0.6911 m/s then both machine will be operated in continuous.

$$V_1=V_2$$

$$\frac{\pi D_1 N_1}{60}=\frac{\pi D_2 N_2}{60}$$

$$V_1=\frac{\pi D_1 N_1}{60}=\frac{\pi \times 0.150 \times 88}{60}=0.6911 \text{ m/s}$$

$$V_2=\frac{\pi D_2 N_2}{60}=\frac{\pi \times 0.100 \times 123}{60}=0.6437 \text{ m/s}$$

$$V_1=V_2$$

$$0.6911=\frac{\pi D_2 N_2}{60}$$

$$0.6911=\frac{\pi \times 0.100 \times N_2}{60}$$

$$N_2 = 133 \text{ rpm}$$

Formula to calculate Motor Speed:

N=120f/p

VFD Calculation:

	Frequency (Hertz)	Speed (rpm)
Initial Reading	32.10	123
	33.10	126.8
	34.10	130
Required Reading	35.00	133

Productivity Improvement Calculation :-

Machine	Process	Weight(Kg) Before Improvement	Weight(Kg) After Improvement
1.	Flattening	450	450
2.	1st Pass forming	400	450
	Final Pass	300	340

Consider 30 days for Productivity Calculation,

Earlier Observation -

Total Output in Kg of two machines- 300 Kg
Time required to complete process-24 hours
Total time available per day-16hours
Therefore, total days required to complete process - (24/16) = 1.5
Output in kg per month-
(300/1.5)*30=6000kg
Production rate/month=
(Total output per month)/(total hours required)
=6000/(16*30)
=12.5kg/hr

After Improvement –

Total Output in Kg of two machines- 340 Kg
Time required to complete process-16 hours
Output in kg per month = 320*30
= 9600 Kg/month

Production rate/month =

$$\frac{\textit{Total Output Per Month}}{\textit{Total Hours Required}}$$

= 9600/480
= 20 Kg/hr

X = Production rate after improvement – Production Rate before improvement
= 20 - 12.5
= 7.5

% Increase In Productivity= $\frac{X}{\textit{Production rate before}} \times 100$

$$= \frac{7.5}{12.5} \times 100$$

$$= 60\%$$

Thus Productivity Increases by 60%

5. CONCLUSIONS

The main objective of this project is to synchronize two wire rolling machine. This has been achieved by controlling speed of forming machine with variable frequency drive. Synchrony between the speed of both machines controlled by installing spring loaded synchronization unit between them by means of sensor, which forward the position of movable roll to electric drive control speed difference is detected & compensated by control system until movable roll has return to its natural position . Work load on worker reduced as loading & unloading of coil is eliminated. % of productivity increased is 60 % .

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