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Reduction in Cycle Time to Achieve Required Spindle RPM for Friction Welding Machine

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Abstract:- Automation or automating certain processes in industries has created competitive environment among the industries. Owing to the current scenario, parent processes for manufacturing of components need to be change. In many industries, despite of availability of resources same traditional approach of manufacturing is opted. The emphasize is given on reducing cycle time so as to improve productivity and also to reduce cost of manufacturing. Improvements are carried upon Friction Stir Welding Machine. This modification has generally reduced cycle time, enhance production and reduced cost of processes.

Keywords:- *Friction Welding(FW), Hydraulics, Cycle Time, Productivity, Cost Reduction.*

I. INTRODUCTION

The definition of Friction Welding (FW) in the American Welding Society (AWS) C6.1-89 standard is as follows: Friction welding is a solid-state joining process that produces coalescence in materials, using the heat developed between surfaces through a combination of mechanically induced rubbing motion and applied load. The resulting joint is of Forged quality. Under normal conditions, the forging surfaces do not melt. Filler metal, flux and shielding gas are not required with this process. In practice, FW is classified into two ways: Continuous drive friction welding and Inertia friction welding.

Friction Welding (FW) is a fairly recent technique that utilizes non-consumable welding tool to generate frictional heat and plastic deformation at the welding location, thereby affecting the formation of a joint while the material is in solid state. Furthermore, FW joints are characterized by the absence of filler induced problems or defects, since the technique requires no filler, and by the low hydrogen content in the joint. An important consideration in welding steel and other alloys susceptible to hydrogen damage. FW can be used to produce Butt, Corner, Lap, T, Spot, Fillet and Hem joints as well as to weld hollow objects, such as tanks and tubes or pipes, stock with different thickness, tapered section and parts with 3 dimensional contours.

Types of Friction Welding processes are listed below:

- Linear Friction Welding
- Spin Welding
- Rotary Friction Welding
- Inertia Friction Welding
- Friction Surface Welding
- Friction Stud Welding

Apart from above mentioned types of friction welding, this paper mainly concentrates on Inertia Friction Welding process used for welding of pipes. In this type of welding process, energy required to make the weld is supplied primarily from stored rotational kinetic energy of the flywheel of FW machine. In inertia welding, one of the workpieces is connected to a flywheel and the other is restrained from rotating. The flywheel is accelerated to a predetermined rotational speed, storing the required energy. The drive rotor is disengaged and workpieces are forced together by friction welding force. This causes the faying surfaces to rub together under pressure. The kinetic energy stored in rotating flywheel dissipated as heat through friction at weld interface as the flywheel speed decreases. And increase in friction welding force (Forge Force) may be applied before rotation stops. The forge force is maintained predetermined time after rotation ceases.

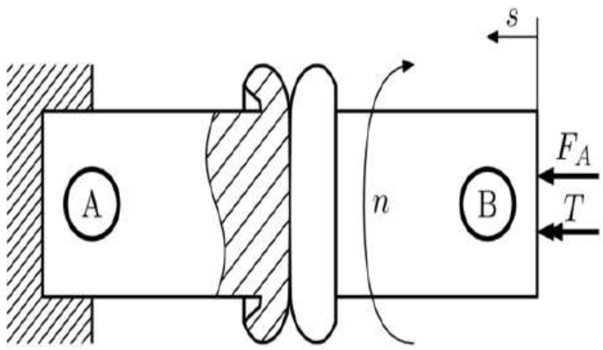

Fig 1:- Tool Joint Process

This process is used for joining tool joints and pipes of considerable length and cross sections. Pipes are manufactured with the help of mechanical processes such as Heat Treatment, Straightening, Cutting edge machine etc. These are the processes that are carried before inertia welding is used to connect two ends. Friction stir welding has numerous advantages over other welding processes and is also feasible when used in case of pipes.

II. DATA COLLECTION AND DEFINING A PROBLEM

A. Data Collection

Before modifying Inertia Welding machine, three hydraulic pumps were used for carrying out process. Namely,

- Clamping pump: This pump is used to clamp the pipe.
- Charging pump: This pump is used to positive suction to main pump.
- Main pump: This pump is used to run the main spindle motor.

Sr. No	Details	Cost (in Rs)
1.	Production Loss for 1 hour due to more cycle time	4 pipes/hour
2.	Approximated cost of Dynapower Hydraulic Power	10,00,000
3.	Power Consumption/hour/year for 11KW	6,74,520
4.	Total cost/ year	16,74,520

Table 1:- Total cost loss due to old Hydraulic System

Processes and Time required to complete 1 cycle before modification are as follows:

Sr. No	Processes	Time (in Sec)
1.	Flapper Up	4.2 sec
2.	Cleaning of jaws and fixing tool joints	108 sec
3.	Spindle Clamp	0.4 sec
4.	Conveyor Forward	15 sec
5.	Auto Mode plus Cycle Start	0.97 sec
6.	Ramp ack in Auto	0.35 sec
7.	Time require to achieve spindle speed	172 sec
8.	Ramp Forward in Auto	30 sec
9.	Time required to unclamp spindle and fixture	1 sec
10.	Time required for conveyor revolutions	14 sec
11.	Time required for Flapper up	4.2 sec
12.	Total time	350.12 sec

Table 2:- Processes and Time required to complete 1 cycle before modification

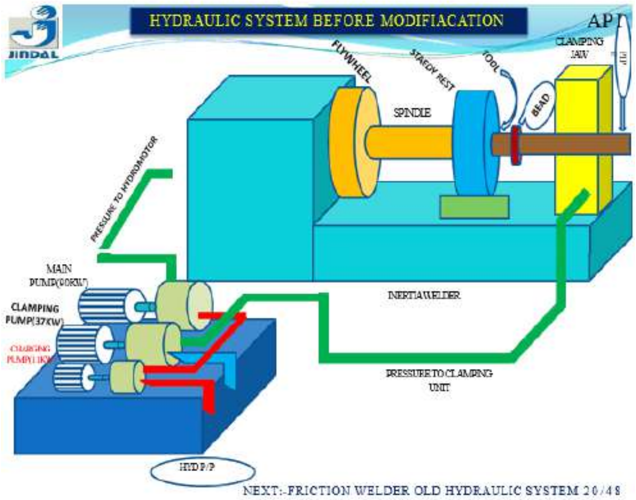

Fig 2:- Old Hydraulic System

B. Defining a Problem

Initially data was collected about inertia welding machine and also time required to complete one cycle. As per above data it can be seen that three pumps were in use for welding process. The system was more power consuming and also complicated. Three pumps were too old, maintenance of these pumps was difficult as spares were not available easily and replacement of all these pumps with same model was not economical. On referring to process chart shown above (In table No 2), it can be observed that time required to achieve spindle speed is more as compared to that of other processes. Reducing this time was the sole purpose as it would automatically enhance productivity of process. The consumption of power by the welding machine was also more due to presence of three pumps. These drawbacks had eventually increased the manufacturing cost of the product. So, the first priority was to minimize the cost while obtaining solution over the reducing cycle time.

III. POSSIBLE SOLUTIONS

Using 5W/1H principle we have developed the solution, hence the action plan prepared is as follows:

What	Productivity is low due to more cycle time
Where	Friction welder
When	From 01/08/2018 to 15/01/2019
Who	With Co-Ordination with members
Why	To reduce the cycle time and energy consumption
How	By modifying old Dynapower Hydraulic System

Table No. 3

By using 5W/1H principle following solutions are obtained:

- Reduce the time while tool loading in fixture Possible, but system becomes bulky resulting in availability of less working area.
- Reduce the time to check tool and pipe alignment Not possible, proper time has to be given to alignment.
- Add one more Hydraulic pump Possible, but cost requirement is more.
- Replace the old Dynapower pump with Indigenous Hydraulic pump Possible, and more feasible and economical.

Above mentioned are the possible solutions that can be implemented, but problem of Dynapower pump is more severe as compared to other problems. So, replacement of pump is carried by procedure mentioned below.

IV. METHOD AND PROCEDURE FOR IMPLEMENTATION OF SOLUTION

Hydraulic clamping pump is used to clamp the pipes in which friction welding is used. Initially there was negative suction at the main pump which have 4000psi maximum pressure and maximum flow of 200LPM with motor rating of 90 KW. To compensate this negative suction, charging pump was used to give positive suction at the main pump. After proper clamping of two pipes is done then spindle with flywheel starts rotating with the help of main hydraulic Dynapower pump. After reaching set RPM value of the flywheel it gets disconnected from hydraulic system and stored energy in flywheel is used to join the tool joint with pipe. For achieving set RPM value time required was more.

After modification, main Yuken make pump A3H145 was installed at the bottom of hydraulic powerpack to give positive suction with 5080psi maximum pressure and 225 LPM maximum flow having motor rating of 75 KW. Power consumption of the system has been reduced to considerable extent. Time required to achieve spindle speed is less as compared to traditional process. No alterations have been done in process as it is precise and accurate as earlier.

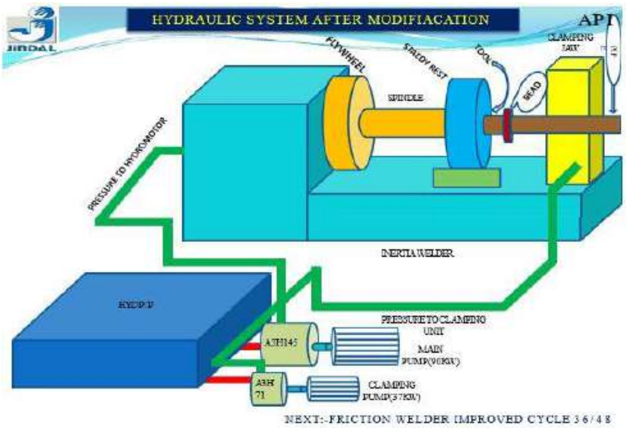

Fig 3:- Modified Hydraulic System

V. RESULTS AND DISCUSSION

Processes and Time required to complete 1 cycle after modification are as follows:

Sr. No	Processes	Time (in Sec)
1.	Flapper Up	4.2 sec
2.	Cleaning of jaws and fixing tool joints	108 sec
3.	Spindle Clamp	0.4 sec
4.	Conveyor Forward	15 sec
5.	Auto Mode plus Cycle Start	0.97 sec
6.	Ram ack in Auto	0.35 sec
7.	Time require to achieve spindle speed	80 sec
8.	Ram Forward in Auto	30 sec
9.	Time required to unclamp spindle and fixture	1 sec
10.	Time required for conveyor revolutions	14 sec
11.	Time required for Flapper up	4.2 sec
12.	Total time	258.12 sec

Table No.4

It can be observed that time required to achieve spindle speed has been successfully reduced. Due to this productivity has been increased resulting in a greater number of components in less amount of time can be produced. Power consumption has also been reduced to some extent due to modification in pump.

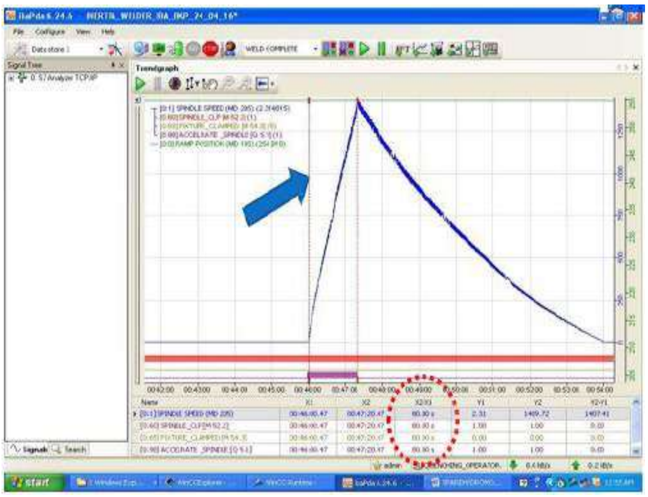

Fig 4:- Spindle RPM achieved in 80 Sec

VI. ADVANTAGES

Due to above modification, following advantages occur:

- Total cycle time of the process is reduced.
- Spares for Indigenous pumps are available easily.
- Power consumption for required pump is lower than initial.
- Total cost required for the process is less than conventional

VII. CONCLUSION

From the above modification we can conclude that cycle time has been successfully reduced by 92 seconds for same operation and increased productivity thereby reducing manufacturing cost of tool joint. Also, replacement of hydraulic charging pump (Dynapower pump) by Indigenous pump has saved the power up to 11 KW. And power saved by main hydraulic pump is up to 15 KW.

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