

Time and Motion Study at Sonalika International Tractors Limited, Hoshiarpur, Punjab

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Abstract—Automobile sector has emerged as a career hub for engineers all over the world. Automobile companies aim to have a balanced production rate which would contribute to increase efficiency in work as well as evolution of some spare time for maintenance of workplaces. These companies spend a lot of expenditure on improving their product in market and promises customers to provide quality services.

This paper addresses how this aim can be achieved. It begins by reviewing the common factors resulting in unnecessary time consumption for a Diesel Engine Assembly. It then discusses how this extra time may be eliminated for optimum production rate. The paper also presents examples of different working methods of assembly from different sections. Drawing these elements of time consumption in assembly of an engine presents an innovative approach for assembly time reduction in tractor diesel engine. It argues that this approach may prove useful for achieving organizational goals in time.

Keywords: Diesel engine, Tractor, Production, Efficiency, Quality service.

1. INTRODUCTION

Today we are living in a dynamic world which is full of complexities. Keeping in view, the changing scenario of the world as a whole, a quality product is required in national and the international market. Quality in essence means complete customer satisfaction, which is possible to be achieved by interlinking the various elements of an organization. Proper investments in various inputs are the pre-requisites for achieving high quality standards. These target levels cannot be achieved by techniques such as quality control, but it is an attitude of mind which leads to appropriate timely action with commitments at every level of a “Zero Defect Product”. In fact, this process involves every department, every section, each activity and every person at each and every level in the industries. In case of developing diesel engine of tractors in any farm industries, the minimum time is required for its assembly with no maintenance cost afterwards, so that the product is to the entire satisfaction of the customer. This way both the industry and customers are benefited.

To achieve this goal of quality, industry and customer satisfaction, a study was conducted on the reduction of time of

the assembly line of a diesel engine of Sonalika Tractor, the industry of which is located at Hoshiarpur, Punjab, India.

Stage time study of four cylinder diesel engine

For a stage time study of four cylinder diesel engine, following points are to be taken into consideration.

1. How to save man power and how to avoid time wastage.
2. The main motive of this study is to find out the time required for mounting of different parts during assembly of an engine. Production time/total parts produced or total operating time / total parts held under the operation of every stage. The contractor has to decide monthly salary of the workers, helpers and operators. The assembly time per stage is noted efficiently.
3. Depending upon the noted time per stage, contractor has to calculate trolley cycle time for each engine in one hour. Depending upon this assembly time of every stage of different components of an engine which are manufactured under hydraulics in one shift, contractor decides to pay salary to all operators and workers.

The various operations during the mounting of a part

1. Preparation of part: It includes heating of gears, testing for leakage and placing nuts. Average time taken by worker to prepare part = 13.45 sec.
2. Cleaning: Before the mounting of any part, mounting area must be cleaned with tissue paper. There should be no dust, burrs present on area. Proper cleaning of oil holes and water jacket holes should be done. The average processing time = 8 sec.
3. Fixing gaskets: Some parts can't be mounted on the crank case directly because without proper insulation, problems like leakage could occur. For this not to happen, insulation like gaskets are applied when required. Average processing time = 10 sec.
4. Oiling: It is the process where workers manually pick parts and place them at their required place after lubricating them. Proper lubrication of parts is required,

otherwise it could lead to excessive heating of engine due to friction, resulting in damage. Average processing time = 45 sec.

5. Tightening of screws: After mounting the part at its place, it is very important to tighten all the screws properly with the amount of torque specified on the worker's manual. Average processing time = 58 sec.
6. Rotating trolley: After the mounting of a part is done, it is required by the worker to manually rotate the trolley on which crank case is temporarily placed. It helps to keep the production line running without false alarms. Average processing time = 38 sec.

Stages of engine assembly:

Stage 1: Crank Casing Fitment. **Average processing time = 5 sec.**

Stage 2: Fitting of tappet, connection plug, sleeve and removal of the crank shaft cover. **Average processing time = 26.58 sec.**

Stage 3: Fitting of the crankshaft assembly, cam shaft, BI gear, TI gear, FI gear, crank gear, cam gear and hydraulic gears. **Average processing time = 1 min. and 34 sec.**

Stage 4 & 5: Fitting of bearing retainer valve and lubrication of bolt. Tightening nuts on the main bearing cap with a torque of 12 kg-m using a DC nut runner. **Average processing time = 36.57 sec.**

Stage 6: Mounting of piston rings. Join piston and connecting rod with the help of a gudgeon pin. **Average processing time = 24.59 sec.**

Stage 7: Inserting the piston into the cylinder. **Average processing time = 15.38 sec.**

Stage 8: Fitting connecting rod assembly on crankshaft. **Average processing time = 34.24 sec.**

Stage 9: Fitting the front cover (hydraulic), elbow cover (transmission) and front cover. Application of m-seal to function as a gasket. **Average processing time = 15.52 sec.**

Stage 10: Fitting the lubrication pump/ oil pump and rear cover. **Average processing time = 20.24 sec.**

Stage 11: Fitting the engine belt on pulleys. **Average processing time = 18.29 sec.**

Stage 12: Fitting the cylinder head. **Average processing time = 1 min. and 42 sec.**

Stage 13 & 14: Tightening nut and bolts of cylinder head. **Average processing time = 35.68 sec.**

Stage 15: Fitting of alternator bracket. **Average processing time = 8.5 sec.**

Stage 16 & 17: Fitting disc plug at the end of cam shaft and fitting of flywheel. **Average processing time = 18 sec.**

Stage 18 & 19: Fitting of suction strainer and reduction valve. **Average processing time = 45.54 sec.**

Stage 20 & 21: Fitting of oil pan and magnetic plug. **Average processing time = 1 min. and 35 sec.**

Stage 22: Fitting of water pump & return lines. **Average processing time = 40.39 sec.**

Stage 23: Fitting of push rod and rocker arm assembly. **Average processing time = 35.28 sec.**

Stage 24: Fitting exhaust flange. **Average processing time = 18.55 sec.**

Stage 25: Fitting of alternator bracket. **Average processing time = 9.24 sec.**

Stage 26: Fitting the oil filter & oil indicator. **Average processing time = 15.38 sec.**

Stage 27: Fit valve cover, thermostat, side cover and breather pipe. **Average processing time = 1min. and 47 sec.**

Stage 28: Fit inlet manifold assembly. **Average processing time = 20.34 sec.**

Stage 29: Fit exhaust gas recirculation pipe for gas cleaning and reusing. **Average processing time = 21.26 sec.**

Stage 30: BDTC is done at 14 degree for all the engines and fuel injection pump timing. **Average processing time = 20.42 sec.**

Stage 31: Fitting the self-starter. **Average processing time = 2 min. and 53 sec.**

Stage 32 & 33: Fitting of oil lines and injector. **Average processing time = 17.25 sec.**

Stage 34: Fitting of diesel filter. **Average processing time = 48.25 sec.**

Stage 35: Fitting of high pressure pump for fuel injection. **Average processing time = 40.25 sec.**

Results:

The average man power required for the part preparation = 1

Average man power required for the part mounting = 2

Maximum time taken for a stage = 2 min 53 sec.

S. No.	Stages	Description (Fitting Of)	Processes Done And Time Taken						Total Time Taken
			Part Prep. (Sec.)	Cleaning	Gasketing	Oiling	Screwing	Trolley Position.	
1	Stage-1	Crank case	-----	-----	-----	Yes	-----	-----	5 sec.
2	Stage-2	Tappet, connection plug, linear (sleeve) and remove the crankshaft cover	Yes	Yes	-----	Yes	Yes	3.59 sec.	26.58 sec.
3	Stage-3	Crank shaft assembly Cam shaft Timing gears	5 min. (Not accounted)	-----	-----	Yes	Yes	3sec.	1 min.34 sec.
4	Stage-4 & 5	Bearing retainer valve and lubrication of bolts. Tighten all nuts	1min. (Not accounted)	-----	-----	Yes	Yes	5.65sec.	36.57 sec.
5	Stage-6	Mount piston rings. Join the piston and connecting rod with the help of a gudgeon pin	-----	Yes	-----	Yes	-----	-----	24.59 sec.
6	Stage-7	Piston into the cylinder	Yes	Yes	-----	Yes	-----	-----	15.38 sec.
7	Stage-8	Connecting rod assembly on crank shaft	-----	Yes	-----	Yes	Yes	Yes	34.24 sec.
8	Stage-9	Cover fitting, m-seal as a Gasket	Yes	Yes	Yes	-----	Yes	Yes	15.52 sec.
9	Stage-10	Lubrication pump / oil pump Rear cover	Yes	-----	-----	Yes	Yes	Yes	20.24 sec.
10	Stage-11	Engine belt pulley	-----	-----	-----	-----	YES	YES	18.29 sec.
11	Stage-12	Cylinder head assembly	Yes	Yes	-----	Yes	-----	-----	1 min. 42 sec.
12	Stage-13&14	Tightening nut and bolts of cylinder head	Yes	Yes	Yes	-----	Yes	-----	35.68 sec.
13	Stage-15	Alternator bracket	-----	-----	-----	-----	Yes	Yes	8.5 sec.
14	Stage-16 & 17	Disk plug & flywheel	Yes	-----	-----	-----	Yes	Yes	18 sec.
15	Stage-18 & 19	Suction strainer & reduction valve	-----	Yes	-----	YES	-----	Yes	45.54 sec.
16	Stage-20 & 21	Magnetic plug & oil pan	-----	-----	Yes	-----	Yes	Yes	1 min. 35 sec.
17	Stage-22	Water pump and return line	-----	-----	Yes	-----	Yes	-----	40.39 sec.
18	Stage-23	Push rod and rocker arm assembly	-----	-----	-----	-----	Yes	-----	35.28 sec.

19	Stage-24	Exhaust flange	Yes	-----	Yes	-----	Yes	-----	18.55 sec.
20	Stage-25	Alternator on alternator bracket	-----	-----	-----	-----	Yes	-----	9.24S sec.
21	Stage-26	Oil filter , oil indicator	-----	-----	-----	YES	Yes	-----	15.38 sec.
22	Stage-27	Valve cover , thermostat , side cover , breather pipe	Yes	-----	Yes	-----	Yes	-----	1 min. 47 sec.
23	Stage-28	Inlet manifold assembly	Yes	-----	Yes	-----	Yes	-----	20.34 sec.
24	Stage-29	Exhaust gas recirculation	-----	-----	Yes	-----	Yes	Yes	21.26 sec.
25	Stage-30	Fuel injection pump timing	Yes	-----	-----	Yes	-----	-----	20.42 sec.
26	Stage-31	Self-starter	-----	-----	-----	-----	Yes	-----	2 min. 53 sec.
27	Stage-32 & 33	Fitting of oil lines and injector.	Yes	Yes	-----	Yes	Yes	-----	17.2 sec.
28	Stage-34	Diesel filter	Yes	-----	-----	Yes	Yes	-----	48.25 sec.
29	Stage-35	High pressure pump for fuel injection	-----	-----	-----	-----	Yes	-----	40.25 sec.

2. CONCLUSION

To achieve the goal of quality and satisfaction of both the customer and industry the study has been conducted and the following results have been achieved by the technique such as quality control which leads to appropriate timely action with commitments at every level of a zero defect product. During the study of various stages the manpower required for different stages held for the assembly of engine has been justified and the time taken for each and every stage of assembly of DL-60 has been calculated.

The Average manpower required for part preparation – 1

Average manpower required for mounting – 2

Maximum time taken for the every stage of the assembly = **2min 53 sec.**

Whenever the line is not functional and the worker be engaged for the preparation of the parts list or they are engaged to keep their workspace neat and clean.

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REFERENCES

- [1] Clair et al., (1996) "Transport network design and mode choice modeling for automobile distribution: A case study".
- [2] Parihar et al., "Value stream mapping: A case study of assembly process" IJERT, Vol. 1, issue 8, 2012.
- [3] Giri et al., "Modeling and optimization of assembly of transmission system through ergonomics consideration: An overview".
- [4] Janulevicius e al., "Tractors engine performance and emission characteristics in the process of ploughing". Vol.75, Nov. 2013, pp. 498-508.
- [5] Chandan et al., "To study the role of manufacturing competency in the performance of Sonalika Tractors Manufacturing Unit" IJEBER 8(1) May 2014, pp. 62-66.
- [6] Coster et al., "Assessment of preparation time with fully liquid versus non-fully liquid pediatric hexavalent vaccine: A time and motion study". Vol.33, issue 32, July 2015.
- [7] Suchaitanawanit et al., "Mechanical structure optimization in min. time: Motion control of flexible bodies". Vol. 62, Dec 2015, pp.213-221.