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Development of High Pressure Coolant System for Machining in Small Scale Industries

Narendra Madhale¹, Hanmant Shete²

M. Tech. Scholar, Department of Mechanical Design Engineering, BMSPM'S Ashokrao Mane Group of Institutions,
Vathar Tarf Vadgaon, Tal- Hatkanangale, Dist.-Kolhapur, Maharashtra, India¹

Professor, Department of Mechanical Engineering, BMSPM'S Ashokrao Mane Group of Institutions, Vathar Tarf
Vadgaon, Tal- Hatkanangale, Dist.-Kolhapur, Maharashtra, India²

ABSTRACT: Machining in difficult to cut situations requires supply of coolant at higher pressure. Most of standard types of CNC, VMC, HMC machines in small and medium scale industries are not equipped with the facility to supply coolant at higher pressures. Hence, these industries are unable to accept the orders of the difficult to cut components in external machining operations. Therefore this paper presents the development of HPC system and its operating performance. The HPC system is capable to generate 100 bar coolant pressure and supply the coolant at different pressures as per the requirement. This system can be easily attached to existing machines to make them capable to perform the different external operations and to machine in the difficult to cut situations. The developed HPC system can result in reduced production cost by improving machining performance and maximizing the utilization of machines.

KEYWORDS: High pressure coolant, High pressure coolant system (HPC), Small scale industry, External machining, Difficult to cut situations.

I. INTRODUCTION

In machining process, tool penetrates into the workpiece and removes the material in the form of chips. Due to temperature and frictional forces between tool-metal chips, wearing of tool occurs. So coolant is used in cutting to remove heat and chips from working area. Dry drilling becomes more difficult as hole depth is increased, since drill temperatures increase and chip removal is difficult. Additionally, processes that are considered as difficult to machine materials such as austenitic stainless steel, because of the low heat conductivity of this material, generated heat cannot be transferred into the work piece. During machining of materials such as titanium, nickel, die steel large amount of heat is generated and severe tool wear occurs. Dry machining or flood coolant machining are not the suitable machining process for such conditions. In such conditions, coolant should be supplied at higher pressures. However, most of CNC, VMC, HMC machines in small and medium scale industries are not equipped with the facility to supply coolant at the higher pressure. Hence, these industries are unable to accept the orders of the difficult to cut components for machining involving external operations like turning, parting, grooving. So it is necessary to design and develop the high pressure coolant (HPC) system. This system can be attached to such machines to make them capable to perform the different operations and to machine in the difficult to cut situations. Therefore this paper presents the design of HPC system especially for small scale industries and its utilization.

II. LITERATURE REVIEW

V. Tic, et al. [1] presents the development of 400 liter hydraulic tank and a full scale hydraulic power unit was built to achieve a better performance. R. Patil et al. [2] presented the study on effect of high pressure coolant (8 to 70 bar) on surface finish during turning operation and concluded that increase of pressure results in improved surface finish. A. Eispfoss et al. [3] explained in detail the basics of power pack elements and design details. H. V. Shete et al. [4] suggested using high pressure coolant for machining of difficult to cut materials. The researchers also pinpointed the need to develop a low cost HPC system suitable for optimizing the utilizations of existing machines in small scale industries for machining of hard materials and to improve the productivity. H. Shete and M. S. Sohani [5] showed that high coolant pressure and spindle speed results in better diametrical accuracy at the bottom of hole during medium



depth drilling process. T. Obikawaa [6] performed CFD analysis to the coolant flow in turning and found that the accessibility of coolant is improved as the speed of coolant is increased.

L.N. Lopez de Localle et al. [7] investigated role of pressurized coolant in drilling and turning operations. M.J. Bermingham et al. [8], Anselmo Eduardo Diniz [9] used HPC pressure found that productivity and tool life was considerably improved with HPC. Power Stream-High Pressure Coolant System Manual [10] specifies key benefits of high pressure coolant system. In this manual study of standard features of key elements and components is studied in detail. This manual also gives instruction about installation of power pack unit and various connections like inlet outlet and electrical wiring. Sandvik Coromat Manual [11] studies requirements, benefits and considerations for HPC system. It also focuses on selection of parameters like pressure, flow rate and velocity for designing of high pressure coolant system. It also gives selection of tool, nozzle diameter, jet direction, etc. It mentions that benefits of using HPC in HRSA machining improve chip control and tool life. Cutting Fluid Manual [12] U.S. Environmental Protection Agency explained cutting fluid systems in detail.

The data related to difficulties and requirements for the use of high pressure coolant from small scale industries is obtained and summarized.

III. DEVELOPMENT OF HPC SYSTEM

Based on the summarized data from literatures and small scale industries, it is decided to design a HPC system capable to produce 100 bar coolant pressure, supply coolant at different pressures, portable and cost wise affordable to small scale industries.

Coolant Pump

Using the CMTI catalogue and based on the supply coolant pressure and cost considerations, external gear pump is selected as shown in Figure 1. The specifications of the pump are given in Table 1.

Table 1 Specifications of the pump

Feature	Specification	Feature	Specification
Type	External gear pump	Flow rate	18 lpm
Pressure (Max.)	170 bar	Manufacturer	VBC Hydraulics, Ahmedabad
Speed	1440 rpm	Pump numb	HL 0622

Electric Motor

Maximum working pressure of pump [14] = Working Pressure + Allowance = 100 + (100 * 0.25) = 125 bar

Pump discharge = 18 lpm = (18 * 0.000017) = 0.00030 m³/s

Shaft Power = Pressure * Flow Rate / 60000 = (12500 * 18) / 60000 = 3.75 KW

Pump power required = Power in KW / 0.746 = 3.75 / 0.746 = 5.02 HP ≈ 5 HP

Table 2 Specifications of motor

Feature	Specification	Feature	Specification
Type	3 phase AC induction motor	Torque	24.9 Nm
Power	5 HP	Weight	35 kg
RPM	1430	Manufacturer	Laxmi Hydraulics Pvt. Ltd., Solapur

Hence a motor of 5 HP is selected as shown in Figure 3. Motor specifications are given in Table 2.

Reservoir tank

The reservoir tank is developed as per the functions of the parts to be fitted, as shown in Figure 2 and then it is fabricated as shown in Figure 3. Tank specifications are given below.

Reservoir tank Capacity [14] = Flow Rate * 5 = 18 * 5 = 90 lpm = 110 lpm [Standard]

Material: Mild Steel powder Coating; Thickness: 2.5 mm; Dimensions: 630 * 500 * 425 mm



Fig. 1 External gear pump

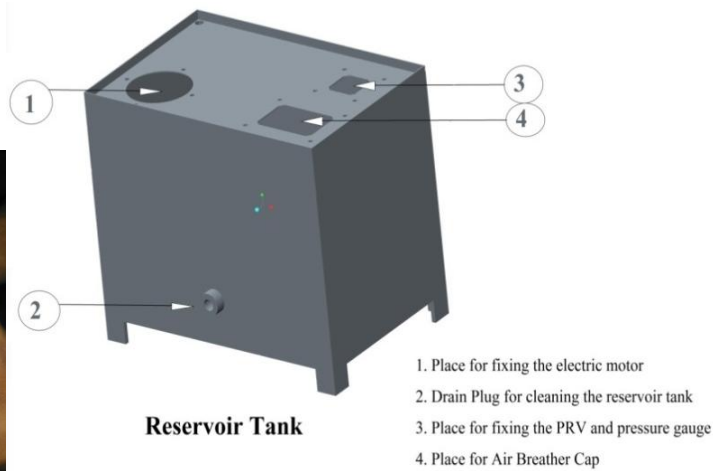


Fig. 2 Reservoir tank


Pressure Gauge

The specifications of pressure gauge (Figure 3) suitable for 100 bar working pressure [13] are:
 Make: Micro make, Gujrat; Range: 0 to 280bar; Measuring element: Bourdon tube

Strainer

Strainer is used to avoid entry of contaminated particles to pump and then to tool. As for machining operation, maximum chip size is 15 micron, wire mesh strainer is selected and as pump flow rate is 18 lpm, using the catalogue the filter of Model No. SC3-010 is selected. The important specifications of this strainer are given in Table 3 along with photo.

Table 3 Strainer specifications

Make	HydrolineProducts Pvt. Ltd.	
Strainer	Wire mesh	
Material	Steel Meshing	
Micron Size	25 micron	
Nominal Pressure	25 - 200 bar	
Nominal Flow Rate	40 lpm	
Maximum Working Temperature	-9° to 82°C	

Hose Pipe

The due consideration is given to the hose selection parameters such as surge pressure, temperature, fluid compatibility, flow capacity, size, length of hose, flexibility, and safety factor as per the requirements.

Burst pressure of hose pipe = 3 x Working pressure = 3x100 = 330 bar (Standard), Where 3 is safety factor.

EN 8531SN/2SN is best suitable hose pipe category for such conditions [13]. Hence a hose of DN 10 is selected (Figure 3) from “SAE 100R2 AT / EN 853 2SN” Catalogue. Specifications of hose are:

Tube: Synthetic rubber; Reinforcement: High tensile steel wire braids; Temperature range: -40°C ~ +100°C; Bore size: 9.5 mm, Wall thickness : 9.5 mm, Braid outside Diameter: 19mm

Pressure Relief Valve

Present work involves, operating pressure of 100bar, semisynthetic fluid, and viscosity is 75 cSt. Hence a direct acting pressure relief valve is selected [13] and its specifications are given in Table 4.

Table 4 Specifications of pressure relief valve

Manufacturer	Polyhydron Pvt. Ltd., Belgaum
Type	Direct acting- poppet type
Flow direction	From P to T
Operating pressure	Port P: 400 bar (Standard model), Port T: 315 bar
Viscosity	10cSt to 380 cSt
Fluid temperature	-20 °C to +70 °C

Assembly of HPC System

Figure 3 shows the fabricated and assembled HPC system for external machining operations.

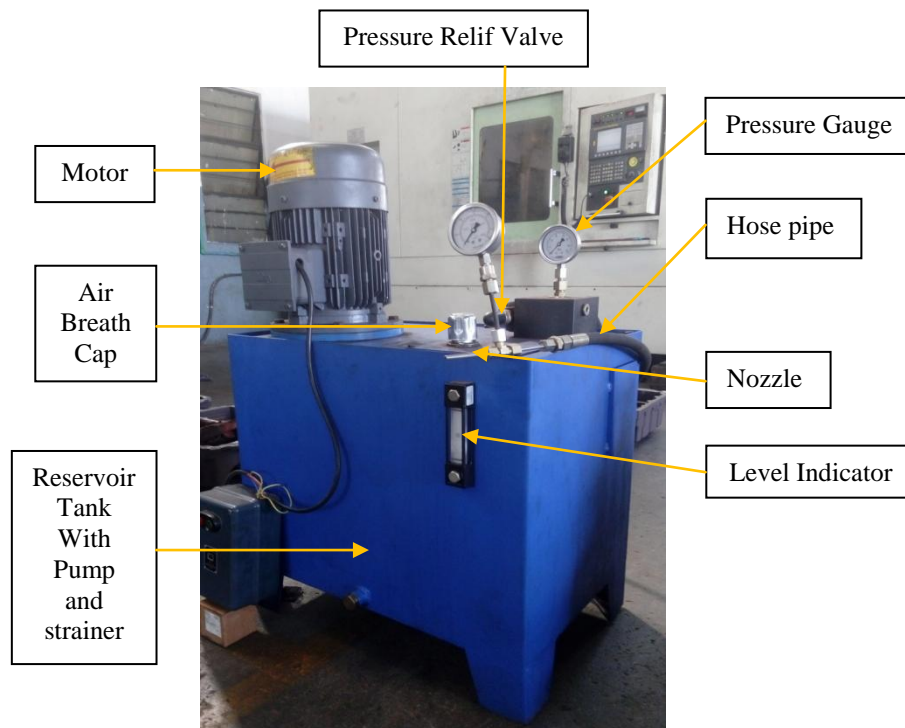


Fig. 3 Developed HPC system

The coolant of required concentration is filled in the tank by opening the pouring cap. When starter is switched to ON, motor starts which run the pump. Pump sucks the coolant which enters from the tank to the strainer and then to the pump. Coolant then enters the outlet of pump with increased pressure energy of coolant and then it passes through the direct acting pressure relief valve unit. The required coolant pressure can be set with this valve. The pressure gauge is mounted to the outlet of valve which shows the pressure of coolant developed by pump. This coolant passes through the hose pipe and then enters the nozzle, which increases the kinetic energy of the coolant. Hence coolant exits the nozzle with high velocity jet. This jet is directed at the cutting area of tool in external machining operations. The coolant pressure can be varied with the valve depending on the work piece material, feed, depth of cut, and speed during marching. At the nozzle pressure energy is converted to the kinetic energy, hence the pressure at the exit of nozzle is lesser than at the pump exit. The cost of HPC system is Rs. 45,000 (INR), which is affordable to the small scale industries.

IV. TESTING OF HPC SYSTEM

The developed HPC system is operated and shows the satisfactory operating performance as shown in Figure 4 to Figure 7. Figure 7 (a) shows turning operation performed on lathe with the supply of high coolant pressure developed by HPC system. Figure 7 (b) shows the jet of coolant developed by HPC system for its use on VMC. It is observed that this HPC system is capable to produce 100 bar coolant pressure (P_d) as well as it can supply coolant at different pressures and can be easily used on CNC, VMC to perform external machining operations. It should be noted that the coolant pressure at the exit of nozzle is always lower than the coolant pressure developed by the pump. The hose should be mounted properly with a fixture on CNC, HMC, VMC to direct the jet of coolant at the cutting area.



Fig. 4 Varying the coolant pressure Fig. 5 $P_d = 50$ bar Fig. 6 $P_d > 100$ bar

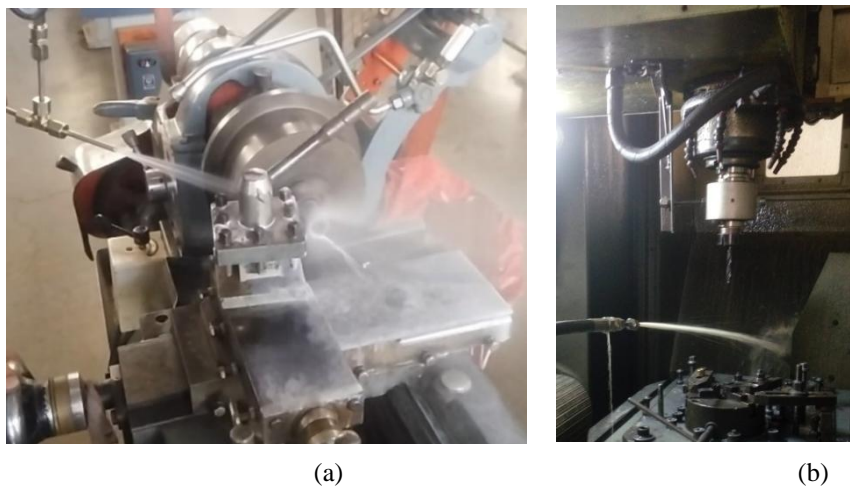


Fig. 7

V. CONCLUSION

The HPC system is developed, fabricated and tested for its operating performance. This HPC system is capable to-

- Develop the 100 bar coolant pressure
- Supply the coolant pressure as per the requirement

It is detachable, portable and the cost of HPC system is affordable to the small scale industries.

The testing of HPC system assures its successful use for the external machining operations on lathe, CNC, HMC and VMC.

Therefore, the developed HPC system will result in-

- Improving the machining performance by cooling, removing the chips at fast rate, reducing the tool wear.
- Maximize the use of existing machines that are not having facility to supply the coolant at high pressures, by performing external machining operations on difficult to cut materials.
- Reduced production cost by improving machining performance and maximizing the utilization of machines.



As a means of future research, filtration system can be incorporated in this HPC system to use it for internal machining operations and flow meter and flow control valve can be employed to supply the coolant as per the required flow rate.

REFERENCES

- [1] V.Tič, D.Lovrec, “Design of modern hydraulic tank using fluid flow simulation”, International Journal of Simulation Modelling, Vol. 11, Issue 2, pp. 77-88, 2012.
- [2] R. A. Patil, V. D. Shinde, H. V. Shete, S. P. Nevagi, “Effect of high pressure coolant on surface finish in turning operation”, International Journal of Innovative Research in Science, Engineering and Technology, Vol.2, Issue 7, 2013.
- [3] A. Esposito, “Fluid Power with Applications”, Pearson publication, 7th Ed., 2020.
- [4] H. V. Shete, M. S. Sohani, “Machining in high pressure coolant environment – a strategy to improve machining performance: a review”, International Journal of Manufacturing Technology and Management - Inderscience Publication, Vol-33, Issue-6, pp. 468-492, 2019.
- [5] H. V. Shete, M. S. Sohani, “Effect of process parameters on hole diameter accuracy in high pressure through coolant peck drilling using Taguchi technique”, International Journal of Material Forming and Machining Processes-IGI Global Publication, USA, Vol-5, Issue-1, pp. 12-31, 2018.
- [6] T.Obikawaa, M.Yamaguchia, “Computational fluid dynamic analysis of coolant flow in turning”, Procedia CIRP, Vol. 8, pp. 271-275, 2013.
- [7] L.N. Lopez de Lacalle, J. Perez-Bilbatua, J.A. Sanchez, J.I. Llorente, A. Gutierrez and J. Alboniga, “Using high pressure coolant in the drilling and turning low mach inability alloys”, The International Journal of Advanced Manufacturing Technology, Vol. 16, pp. : 85-91,2000.
- [8] M.J. Bermingham, S. Palaniswamy, D. Morr, R. Andrews, M.S. Dargusch, “Advantages of milling and drilling Ti-6Al-4V components with high pressure coolant”, International Journal of Advanced Manufacturing Technology, pp. 77-88, 2014.
- [9] A. E. Diniz, R.Micaroni, A. Hassui, “Evaluating the effect of coolant pressure and flow rate on tool wear and tool life in the steel turning operation”, The International Journal of Advanced Manufacturing Technology, Vol. 50, pp. 1125–1133, 2010.
- [10] Power Stream High Pressure Coolant System Manual, August 2005, LNS Publication, No. 864510-0016 T.
- [11] SandvikCoromant Manual, 6, 2010.
- [12]Cutting Fluid Manual, U.S. Environmental Protection Agency, Risk Reduction Engineering Lab under Cooperative Agreement, CR 821492-01-2.
- [13] Hydraulic Power Pack-ebook, <https://www.target-hydraulics.com/hydraulic-power-pack-ebook/>
- [14] Mahmoud Galal, El-Din Mohamed Rabi, “Fluid Power Engineering”, McGraw-Hill Publication, 2009.



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