CHAPTER 6

CONCLUSION
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CONCLUSION AND FUTURE SCOPE

6.1 INTRODUCTION:

Cutting fluids are employed in machining to reduce friction, cool the work piece, and wash away the chips. With the application of cutting fluid, the tool wear reduces and machined surface quality improves. Often the cutting fluids also protect the machined surface from corrosion. They also minimize the cutting forces thus saving the energy. These advantages of using cutting fluids in machining are accompanied by a number of drawbacks. Sometimes the cutting fluid costs are more than twice the tool-related costs. Most of the cutting fluids possess the health hazard to the operator. Disposal of the used cutting fluid is also a major challenge.

Cutting fluids often pose hazard to man, machine, and material. A cutting fluid with fatty material reacts with the zinc and produces zinc soap. Hence, the use of galvanized tanks, pipes, and fittings should be avoided with it. Fatty oil based fluids readily oxidize, particularly in the presence of a catalyst like copper. Thus, during the machining of copper, fat is converted to organic acid which reacts with exposed copper surface to produce green color copper soaps. Presence of chlorine also poses health hazard. Sulfur also reacts with many metals to make sulfides. Water-mix fluids cause staining and corrosion. They also produce micro organisms. All water-mix cutting fluids are alkaline for inhibiting the corrosion. It also helps to control the growth of microorganisms. However, excessive alkalinity causes irritation to human skin. It also causes corrosion problems in aluminum and zinc. As the magnesium is very reactive with water, it should not be machined with water-mix fluid. Synthetic fluids usually contain triethanolamine which reacts with copper. They are also not suitable for machining of aluminum. A number of occupational diseases of operators are due to skin contact with cutting fluids. Direct skin contact can cause an allergic reaction or dermatitis. The petroleum products that are basis for the majority of the fluids are suspected carcinogens. It was noted that machinists exhibited a higher rate of upper respiratory cancer than other workers. Applying the cutting fluid in the form of oil mist also poses serious health hazards. The contact of mist with eye may cause irritation and the mist may affect adversely to asthma patients. It may also cause long time breathing disorders.

The disposal of cutting fluids is also a big problem. The waste cutting fluids can pollute surface and groundwater. They can cause soil contamination, affect agriculture produce, and can
lead to food contamination. Thus, ideally, cutting fluids should not be used at all. If it is not possible, then their use should be minimized. One alternative is to develop completely safe cutting fluids, but they may not be competitive due to economic consideration.

6.2 CONCLUSIONS:

From the experimental work and the analyses conducted by the author, it has been possible to consolidate and highlight some fundamental findings, not available earlier, in regard to comparison of dry, MQL and flooded turning. By application of servo cut S as oil lubricant during the MQL turning, which when mixed with water, produce adequate cooling effect and subsequently result in significantly low values of surface roughness and tool wear with optimum values of speed, feed and depth of cut.

Results obtained by the author may be summarized as a concluding part of the thesis, which would bring adequate knowledge base for professional technocrats working in the manufacturing areas.

Some of important conclusions can be put as under:

The exponential equations for surface roughness and tool wear in case of dry turning are

\[
Ra=9.20 \cdot 10^{10} \cdot v^{-4} \cdot f^{1.49} \cdot d^{-0.15}
\]

and

\[
Tw = 9.189 \cdot 10^{-8} \cdot v^{2.897} \cdot f^{0.0788} \cdot d^{0.7845}.
\]

From the above equations it can be concluded that

1. In case of Dry turning of AISI H13
   - For Surface Roughness (Ra) Cutting speed is the dominant factor followed by feed and depth of cut.
   - For Tool wear (TW) Cutting speed is the dominant factor followed by depth of cut and feed.
   - Major pattern of tool wears found: Abrasion, Adhesion, Notch, Chipping off, Welding of chips.
   - At low and moderate cutting speed, feed marks observed whereas at higher cutting speed feed marks were absent.
• Genetic algorithm with population size 60 and no. of generations 1000 is used to optimize the values of surface roughness and tool wear. From GA we obtained the following optimum parametric set of values.
  Cutting Speed: 251 m/min, feed: 0.05 mm/rev, Depth of cut: 0.10 mm, Ra = 0.40 μm, TW = 0.32 mm.

2. In case of MQL turning of AISI H13 the exponential equations for surface roughness and tool wear are as follows.
  \[ Ra = 9.85 \times 10^9 \cdot v^{-3.65} \cdot f^{0.757} \cdot d^{0.235} \text{ and } Tw = 8.038 \times 10^{-8} \cdot V^{3.07} \cdot F^{0.081} \cdot D^{0.6345} \]
  From the above equations it can be concluded that
  • Chip curling occurs more comparative to dry cutting.
  • Golden yellow color chips are observed
  • MQL found promising in the cutting speed range 200 – 250 m/min
  • At higher cutting speed, MQL effect is low
  • Lower surface roughness and lower tool wear values were found at the following cutting conditions.
    Cutting Speed: 250 m/min, feed: 0.05 mm/rev, Depth of cut: 0.15 mm,
    Ra = 0.37 μm, Tw = 0.39 mm.

3. In case of flooded turning of AISI H13
  • Lower surface roughness and lower tool wear values were found at the following cutting conditions.
    Cutting Speed: 251 m/min, feed: 0.05 mm/rev, Depth of cut: 0.10 mm, Ra = 0.42 μm, TW = 0.38 mm


5. The thesis suggests a newly developed and fabricated set up for MQL turning which gives encouraging results leading to minimum surface roughness and tool wear. This set up can be used in the industry for the betterment of productivity and quality.

6. MQL is consumption lubrication, that is, the most of the lubrication applied is evaporated at the point of application. This evaporation in combination with the compressed air cools the work piece and tool remains nearly dry in ideally adjusted MQL system. MQL reduces induced thermal shocks and helps to increase the work piece surface integrity in high tool pressure.
7. The most significant contribution of application of MQL technique by carbide insert has been the reduction in flank wear, which would enable remarkable improvement in tool life. Such reduction in tool wear might have been possible for prevention of abrasion and notching, decrease or prevention of adhesion and diffusion type thermal sensitive wear at the flanks and reduction of built up edge formation which accelerates wear at the cutting edges by chipping and flanking. Deep notching and grooving which are very detrimental and may cause premature and catastrophic failure of the cutting tools are remarkably reduced by MQL.

8. MQL reduces the flank wear remarkably. This is due to the lubrication provided by the MQL jet which reaches to the work tool interface.

9. Surface roughness grows quite fast under dry machining due to more intensive temperature and stresses at the tool tips which is reduced in MQL.

10. MQL improves surface finish depending upon the work tool materials and mainly through controlling the deterioration of the cutting edge by abrasion, chipping and built up edge formation.

11. With the increase in temperature, the rate of growth of flank wear and thermal expansion of the job will increase; MQL takes away the major portion of the heat and reduces the temperature resulting decrease in dimensional deviation desirably.

12. From the discussion presented in this study, it is apparent that MQL systems possess many advantages over dry and flooded coolant system. However, some modification of machine tools for obtaining the best performance out of them is also required. When the flood coolant system is not present, the machine tools should be equipped with a chip removal system. There is additional cost involved in the equipment for MQL. A cost-benefit analysis is required before implementing MQL system.

13. Minimum quantity cooling lubrication systems are a considerable possibility to realize the function lubrication, necessary for instance to realize a certain surface quality or to achieve economic tool-life, with a minimum amount of cooling lubricant. It depends on the machining operation and the technology, whether this cooling lubrication technology is practicable. The results of the experiments illustrate that minimum quantity lubrication can be applied to various machining operations. An additional potential for the increase of the economic efficiency is given by the loss of the waste disposal problems for the
worn out cooling lubricant and oiled-up chips or the possible renouncement of workpiece washing operations.

14. A Teaching Learning Based Optimization (TLBO) algorithm is used to cross validate the results obtained by Genetic Algorithm in case of minimum quantity lubrication turning.

Results by GA;
Cutting Speed: 250m/min, feed: 0.05 mm/rev, Depth of cut: 0.1mm, Ra = 0.37μm,
Tw = 0.39

Results by TLBO
Cutting Speed: 300m/min, feed: 0.05 mm/rev, Depth of cut: 0.1mm, Ra = 0.17μm.
Cutting Speed: 200m/min, feed: 0.05 mm/rev, Depth of cut: 0.1mm Tw = 0.52mm.

From the above results we can conclude that in TLBO the solution is continuously improved and also it gives better results as compared to genetic algorithm. So this method can also be considered for optimization purpose.

6.3 FUTURE SCOPE:

The demand of safe environment force the industry using minimum quantity of lubrication (MQL) tending to near dry machining. The work in this area of MQL needs to be amplified specially in hard-to-cut materials. Optimum parametric relationships of input and output parameters, developing mathematical equations would help and lead cost conscious professional technocrats towards green and clean environment on shop floor keeping workforce away from occupational hazards and diseases.

Meticulous experimentation on commonly used materials with nano fluids should be a next step to study in depth for the parameters operating in a wide range of values affecting different process outputs, which are of functional and operational importance. Similar type of work can be carried out on composite materials and nano materials. The output parameters like material removal rate (MRR), temperature, forces can be considered. Modifications in MQL equipment can also be the new area of research. The similar work can be deployed for different manufacturing operations.
The methods like Particle Swarm Optimization (PSO), Teaching Learning Based Optimization (TLBO) algorithm can be considered for optimization purpose.

The data base may be prepared for optimum parametric relationships. The ready-to-use data, thus be made available to manufacturing technocrats for simple and rapid process planning and also for designing of products.

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