

## ABSTRACT

Finishing is the final operation performed in most of the manufacturing processes. Finishing operations costs as much as 15 % of the total manufacturing cost in a production cycle. In the finishing process, the main criterion is to achieve (minimal) better surface roughness. Surface roughness plays a vital role in deciding the overall functionality of the component during its life span. Smaller the component size more is the effect of surface roughness in determining its functioning. Traditional abrasive finishing processes are used to finish simple components geometries. However, advancement in technology necessitates the use of components made of difficult to finish materials having complex external and internal surface features. Due to the process limitations, traditional finishing processes cannot be used for finishing such components. To overcome the limitations of traditional finishing processes in meeting the modern manufacturing industries demands, several advanced finishing processes are developed by researchers.

Abrasive flow finishing (AFF) process is an advanced finishing process used for finishing of macro and micro features. In the literature several researchers developed various AFF setups, but flexibility of using same setup for finishing of macro featured and micro featured components is limited. Not much attention is paid on finishing surgical stainless steel cylindrical tubes with the help of AFF process. Limited literature is available on finishing of micro features (microholes and microslots) by AFF process. Detailed study in the field of modeling AFF process during finishing of macro features is unavailable. Also, no such modeling for AFF process is done in the field of micro features.

In the current thesis a flexible AFF setup (can be used for finishing macro as well as micro features of workpieces) is designed and fabricated. Economic AFF medium is developed in-house to replace the commercially used expensive AFF medium. Various medium compositions are made for finishing of macro and micro features. Detailed rheological study (static and dynamic) of the developed medium is carried out with the help of parallel plate rheometer.

Current work includes detailed experimental study of the AFF process during finishing of surgical stainless steel (SS 316L) workpieces with macro to micro features. Tubes with an internal diameter of 12.70 mm, microslots with width  $440 \pm 10 \mu\text{m}$  and microholes having radius  $425 \pm 15 \mu\text{m}$  are finished with the help of developed AFF setup and medium. Surface topography of the initial and finished workpiece surface is studied with the help of non-

contact type profilometer and scanning electron microscope. The best surface roughness obtained is 48 nm, 192 nm and 130 nm during finishing of tubes, microslots and microholes respectively.

Finite element model of the viscoelastic medium during finishing of tubes, microslots and microholes are developed to evaluate the finishing stresses developed during the medium flow. The major development of the analysis is the incorporation of experimentally measured rheological properties of the medium as input. The predicted values of finishing stresses by these models are more accurate compared to the existing models. Surface roughness simulation models are also proposed in this work to predict the surface roughness achieved on the workpiece surface during the AFF process. Developed simulation models are computationally less expensive. Incorporation of the real initial surface roughness profile and abrasive with multiple cutting edges are the major novel points of the simulation model. With a maximum error of 13 %, 7 % and 8 % there is a good agreement between the simulated and experimentally obtained values of percentage change in surface roughness during finishing of tubes, microslots and microholes.