SJIF Impact Factor (2025): 8.688| ISI I.F. Value: 1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 10 | Issue: 3 | March 2025 - Peer Reviewed Journal

# DESIGN, FABRICATION AND ANALYSIS OF TUMBLING MACHINE

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**ABSTRACT**
*The paper presents an analysis of the applicability of tumbling machining for smoothing sharp edges and deburring. The basic conditions for the formation of burrs in machining and shapes of burrs on the edges of objects machined, at the exit of the tool have been defined. Possible ways of removing burrs are quoted. The results of research of deburring and smoothing, rounding sharp edges using tumbling machining are presented. To illustrate the surface taper ratio and edge the optical microscope Nikon Eclipse MA 200 with the image analysis system NIS 4.20 was used. The effect of treatment time on the final effect of removing burrs from aluminium tube after cutting with band saw was defined. Vibro-abrasive machining operators are exposed to loud occupational noises when loading and unloading the metal products in vibro-abrasive machining. The increase in the number of hearing loss injuries in the metal stamping industry initiated OSHA's Special Emphasis Programs in designated industries and locations across the United States. Because occupational hearing loss injuries do not manifest themselves until years later, it is critical that employers install engineering controls immediately in order to protect worker's hearing and prevent hearing loss injuries.*
**KEY WORDS:** *Fine Machining, Tumbling Machine, Tumbling, Finishing Process, Abrasives*

## INTRODUCTION

A tumbling machine have an action that is similar to filing. An eccentric, rotating weight shakes the tub in a circular path, during which the entire load is lifted up at an angle and then dropped. As the load is falling the tub returns to an upward position, applying an upward and angular force that causes a shearing action where the parts and media rub against each other. Vibratory finishing systems tend to produce a smooth finish because the media essentially laps the parts. Since the load is moving as a unit, fragile parts are safe in the vibrator. There is no tearing action or unequal forces that tend to bend and distort parts. The larger the parts or media are, the faster the cutting action. The frequency and amplitude of the machine controls the finish of the parts. The frequencies can vary from 900 to 3600 cycles per minute and the amplitude can vary from 0 to 4.76 mm. High frequencies, 1800 CPM or greater, and small amplitudes are used for fine finishes or delicate parts, whereas large amplitudes are used for heavier cutting. High frequencies and amplitudes can roll burrs and peen edges. The circulation of parts is best at higher frequency therefore, heavy pieces are run at these high frequencies with moderate amplitudes. Despite the apparent rubbing action of particles against parts, studies show that the primary mechanism of material removal in vibratory finishing is erosion caused by the relatively normal impacts of particles on parts. These impacts occur at the same frequency as the vibration, and at impact velocities of less than 1 m/s.

### Working Principle

**Loading the material**: The parts to be processed are loaded into the rotating drum also called a barrel or tumbler. Along with the parts, a mixture of abrasive media e.g., ceramic, plastic, or steel media and a polishing compound or water might be added.
**Rotation and tumbling action:** The drum rotates on its axis, causing the parts and the abrasive media inside to tumble. As the drum rotates, the parts are constantly moving and colliding with each other and with the abrasive media. This action mimics the natural tumbling or erosion process.
**Friction and abrasion**: As the parts collide with the abrasive media, friction occurs, and the media grinds, smooths, or polishes the parts. The media's action can also help remove any unwanted burrs, scale, or oxidation from the surfaces of the parts.
**Time and speed control:** The tumbling machine operates at varying speeds and for a specific amount of time depending on the material being processed and the desired outcome like polishing, cleaning, or deburring. Different materials or applications may require different speeds, time intervals, and types of media.
The working principle of a tumbling machine is based on the process of tumbling or rotating a material such as metal, plastic, or ceramic parts inside a rotating drum or barrel to perform specific finishing operations.

### Experimental Setup

**1. Machine Design and Components**

- **Tumbling Drum or Chamber**: The main component where the material is placed. This chamber typically rotates at a specific speed to create tumbling motion. It can vary in size depending on the materials to be tested.
- **Drive Mechanism**: Motors, pulleys, and belts to rotate the tumbling drum.

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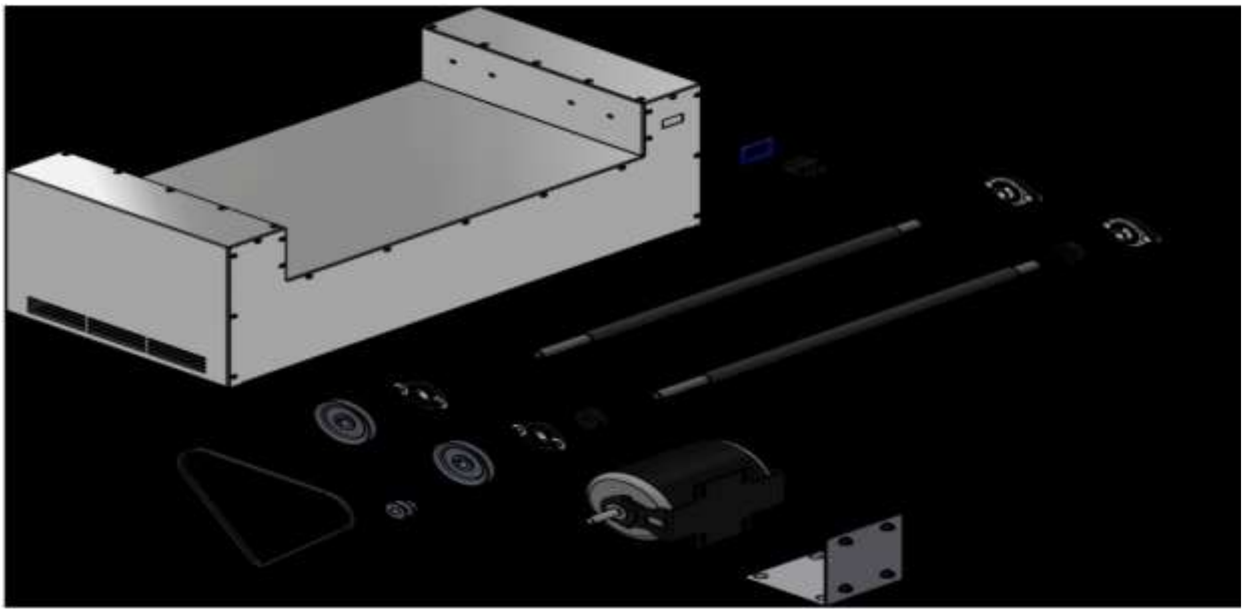
- **Control System**: Allows precise control over the speed, rotation direction, and time of the tumbling process. It could include variable speed drives (VSD) or programmable logic controllers (PLC).
- **Sensor Setup**: Sensors such as load cells, temperature sensors, or vibration sensors to monitor the operational conditions.
- **Material Loaders**: Mechanism to load materials into the chamber, sometimes automated or manually.
- **Material Discharge System**: A way to unload or discharge materials after the tumbling operation.

**2. Material Selection**

- **Test Material**: Different types of materials (e.g., metal balls, rocks, granules, ceramics) to evaluate how they respond to tumbling.
- **Sample Size**: Define the quantity and weight of materials to be used in each test.
- **Surface Area & Shape**: Material shapes like spherical, angular, etc. affect how they interact during tumbling.

**3. Experimental Conditions**

- **Tumbling Speed**: Set the speed at which the drum will rotate. Speed can be varied depending on the test.
- **Time Duration**: The amount of time the material will be subjected to tumbling.
- **Drum Inclination**: In some setups, the angle of the drum may be adjustable to simulate different conditions or for specific processes.
- **Environmental Conditions**: Temperature, humidity, and atmospheric pressure can influence material behaviour.
- **Fill Ratio**: The amount of material relative to the drum's capacity.
- **Lubricants/Chemicals**: If applicable, specific chemicals or lubricants may be added to study their effect on the tumbling process (e.g., polishing media).



**Design Calculation**

The following is the design procedure for shaft:
P=5KW
N=400RPM
Shock factor (Kb)= 1.25, Fatigue factor (Ka) = 1.5
Ultimate tensile stress = 400 $Nmm^2$
Yield tensile stress = 240 $Nmm^2$
Pulley is apart 500 mm
Step 1: Applying ASME code to find Ʈ permissible Ʈper=0.3 × Syt = 0.3 × 240 = 72 Nmm2 Ʈper=0.18 × Sut=0.18 × 400 = 72 Nmm2
Pulley are key to shaft reducing smaller values by 25 % Ʈper = 0.75 × 72 = 54 $Nmm^2$ Ʈper = 54 $Nmm^2$
Step 2: Calculate Torque Transmitted
T = 9548 x P/ Speed
= 9548x 5/ 400

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= 119.35 N-m
= 119350 N-mm
Torque is transmitted by belt drive
Torque= (T1-T2)×R
119350=(T1-T2)×150
(T1-T2) =795.66
Also T1 = 2.5T2
(2.5T2-T2) =795.66
T2=530.44 N-mm
T1=1326.117 N-mm
Step 3: To find diameter of shaft
$T = \pi/16 \text{ x } D^3 \text{x } \tau$
$119350 = \frac{\pi}{16} \text{ x } 72 \text{ x } D^3$
D = 20.36
D =22mm

**Results**

- After tumbling, the grain size distribution gets finer.
- Loss in the weight of the workpiece after tumbling as the surface brushes against abrasive material.
- Increased torque might indicate higher friction, which can slow down the process and indicate inefficient grinding.
- In polishing applications, the goal is to smooth the surface of materials, often using abrasive media.
- During the tumbling process, heat can be generated due to friction, and this may affect the results, particularly when sensitive materials are involved.

**Future Scope**
The future scope of tumbling machines holds great potential for innovation and expansion across various industries. As materials science, automation, and precision engineering continue to advance, tumbling machines are likely to evolve and be adapted for new applications. Here are some key areas where the future scope of tumbling machines.

1. **Automation and Smart Tumbling Systems:**
   Tumbling machines are increasingly becoming part of automated production lines. Future developments will likely focus on integrating tumbling systems with advanced control systems, sensors, and real-time data collection to optimize performance.
2. **Energy Efficiency:**
   Future tumbling machines may incorporate more energy-efficient drive systems, including variable speed drives and regenerative braking, to minimize energy consumption and reduce operational costs.
3. **Advanced Material Processing:**
   Tumbling could be further developed for precise surface modifications, such as micro-texturing, coating, or functionalizing materials at the surface level.

## CONCLUSION

A tumbling machine plays a crucial role in various industries, particularly for processes such as grinding, polishing, mixing, and surface finishing. These machines operate by rotating materials inside a drum or chamber, causing them to experience mechanical impacts, friction, and abrasion, which results in material breakdown, smoothing, or blending

**Efficiency**: With the right settings, tumbling machines can process large volumes of material in a relatively short period, leading to increased throughput and reduced operational time.

**Improved Product Quality**: The tumbling process ensures uniformity in particle size distribution, smoothness, or mixture consistency, which is critical in applications like grinding, polishing, and mixing.

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