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APPLICATION AND MECHANICAL FINISHING OF STAINLESS STEEL IN FOOD INDUSTRIES FOR MANUFACTURING OF TANKS

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Abstract:
This article gives you important guidelines for the manufacturing of vassels from different grades of stainless steel which are most widely used in pharmaceutical, food, dairy, and brewery industries. This article also includes the various mechanical surface finishing operations for final use in dairy for storage and process of milk, ghee, butter milk, etc. This also includes the complete procedure to manufacture the milk storage tank from raw material like plate and coil. Apart from manufacturing process brief of surface finishing process is also detailed which gives the shining to the tank at vertical and horizontal joint

Keywords- Food industry; *Pharmaceutical*; Stainless Steel, tank, Beverage Industry; Mechanical finishing

I. INTRODUCTION

Stainless steels offer a number of properties that make them highly suitable for food industries
They are:

- Hygienic and easy to clean
- Resistant to corrosion
- Sustainable
- Maintenance friendly
- Fully recyclable.

For these reasons, stainless steels is used widely in food industries, food production, and kitchen equipment, domestic appliances As well as in pharmaceutical and beverage industries etc.

This paper often reach small and medium sized companies, who are increasingly faced with developments in materials, finishes and technologies like sheet metal working, laser welding that they may not understand or be fully up to date with. Finishing operations like grinding, polishing and brushing require special attention to get the optimum service performance and life from stainless steel fabrications.

This part of the fabrication process could indeed be seen as the manufacturer's "quality label" and provides an excellent opportunity, if carried out properly, to demonstrate the benefits of the stainless steel. This paper outlines mechanical finishing methods that are appropriate for stainless steel fabrications, describing and illustrating current "best-practice" and emphasizing some of the differences between carbon steel and stainless steel

1.1. TYPE 305

Type 305 (UNS S30500) is an austenitic chromium-nickel flat rolled stainless steel that has excellent corrosion resistance due to a higher nickel content. This increased nickel content also allows the alloy to be used for deep drawing applications.
305 stainless steel flat rolled coil is used mainly in applications that require corrosion resistance.

1.2. TYPE 321

The most commonly specified austenitic (chromium-nickel stainless class) stainless steel , ac- counting more than half of the stainless steel produced in the world. This grade withstands ordinary corrosion in architecture, is durable in typical food processing environments, and resists most chemicals.

Type **321** (UNS S32100) is an austenitic **flat rolled coil stainless steel** that has fives times more titanium than carbon in its content. The increased titanium level aids in preventing carbide precipitation during welding. As a result, Type 321 is both creep resistant and resistant to oxidation. 321 stainless steel flat rolled coil is generally used in applications that require sustainability to high intermittent temperatures.

1.3. TYPE 304 / 304L

Type 304 is The most commonly specified austenitic (chromium-nickel stainless class) stainless steel, ac- counting more than half of the stainless steel produced in the world. This grade withstands ordinary corrosion in architecture, is durable in typical food processing environments, and resists most chemicals. Type 304 is Available in virtually all product forms and finishes

1.4. TYPE 316 / 316L

Austenitic (chromium-nickel stainless class) stainless steel containing 2%-3% molybdenum (whereas 304 has none). The inclusion of molybdenum gives 316 greater resistance to various forms of deterioration

1.5. Chemical composition of stainless steel 302 grade

CHEMICAL COMPOSITION – 302	
CHROMIUM (Cr)	17-19
NICKEL (N)	8-10
MAGANESE (Mn)	2.00 max
CARBON (C)	0.15 max
SULFUR (S)	0.030 max
PHOSPHORUS (P)	0.045 max
SILICON (Si)	1.00 max
MECHANICAL PROPERTIES (ANNEALED CONDITION **302**	
Ultimate Tensile Strength psi - 100,000	
0.2% Offset Yield Strength psi - 40,000	
Percent Elongation in 2 inches – 50	
Hardness Rockwell - B85	

1.6. Chemical composition of stainless steel 304 grade

CHEMICAL COMPOSITION - 304	
CHROMIUM (Cr)	18-20
NICKEL (N)	8-10.50
MAGANESE (Mn)	2.00 max
CARBON (C)	0.08 max
SULFUR (S)	0.030max
PHOSPHORUS (P)	1.00 max
SILICON (Si)	0.045 max
MECHANICAL PROPERTIES (ANNEALED CONDITION **304**	
Ultimate Tensile Strength psi - 95,000	
0.2% Offset Yield Strength psi - 40,000	
Percent Elongation in 2 inches – 50	
Hardness Rockwell - B80	

1.7. Chemical composition of stainless steel 304L grade

CHEMICAL COMPOSITION – 304L	
CHROMIUM (Cr)	18-20
NICKEL (N)	8-12
MAGANESE (Mn)	2.00 max
CARBON (C)	0.03 max
SULFUR (S)	0.030max
PHOSPHORUS (P)	1.00 max
SILICON (Si)	0.045 max
MECHANICAL PROPERTIES (ANNEALED CONDITION **304L**	
Ultimate Tensile Strength psi - 90,000	
0.2% Offset Yield Strength psi - 40,000	
Percent Elongation in 2 inches – 50	
Hardness Rockwell - B80	

1.8. Chemical composition of stainless steel 316 grade

CHEMICAL COMPOSITION – 316	
CHROMIUM (Cr)	16-18
NICKEL (N)	10-14
MO	2-3
MAGANESE (Mn)	2.00 max
CARBON (C)	0.08 max
SULFUR (S)	0.030max
PHOSPHORUS (P)	0.045 max
SILICON (Si)	1.00 max
MECHANICAL PROPERTIES (ANNEALED CONDITION **316**	
Ultimate Tensile Strength psi - 90,000	
0.2% Offset Yield Strength psi - 40,000	
Percent Elongation in 2 inches – 50	
Hardness Rockwell - B80	

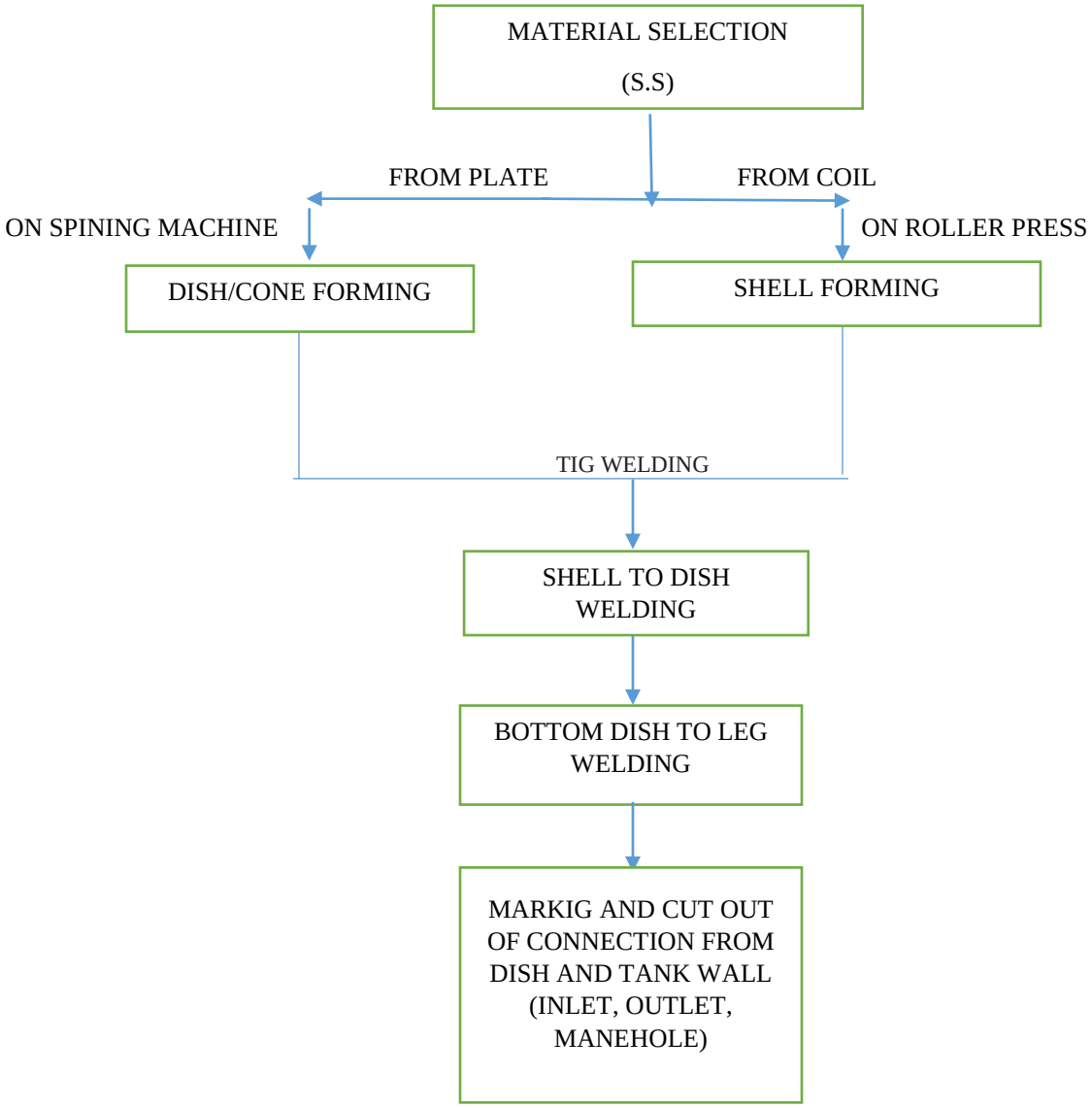
1.9. Chemical composition of stainless steel 316L grade

CHEMICAL COMPOSITION - 316L	
CHROMIUM (Cr)	16-18
NICKEL (N)	10-14
MO	2-3
MAGANESE (Mn)	2.00 max
CARBON (C)	0.03 max
SULFUR (S)	0.030max
PHOSPHORUS (P)	0.045 max
SILICON (Si)	1.00 max
MECHANICAL PROPERTIES (ANNEALED CONDITION **316L**	
Ultimate Tensile Strength psi - 90,000	
0.2% Offset Yield Strength psi - 40,000	
Percent Elongation in 2 inches – 50	
Hardness Rockwell - B80	

II. TANK MANUFACTURING PROCESS

Tank contains mainly two components: vessels which stores the required product and legs Vessels are divided into three parts top dish/cone, bottom dish/cone and shell Top dish/cone and bottom dish/cone are manufactured from plate the standard size of plates are 1250*2500 and 1500*3000 to form dish/cone blank diameter is cut out from plate .then to form dish from blank diameter it is taken to spinning machine so it will get its desired shape either cone or dish. Shell of vessels is generally form from the coil. If we want to manufacture the shell having inner diameter of one meter then we need to cut the piece of 3140 mm long from coil That piece is taken to the roller press for rolling and giving the shape of shell from coil

piece.to form a complete shell from rolled shell welding process starts vertical joint is prepared by TIG welding. Argon gas is used for welding .similar welding process is revised to joint top dish/cone and bottom dish/cone to shell and hence the complete vessel. The next step is to weld the legs to bottom dish/cone of vessel if the orientation of vessel is vertical then in dairy industry it is known as VMST: Vertical milk storage tank. And if the orientation is horizontal then it is known as HMST: Horizontal milk storage tank.



(TANK MANUFACTURING PROCESS)

III. MECHANICAL SURFACE FINISHING

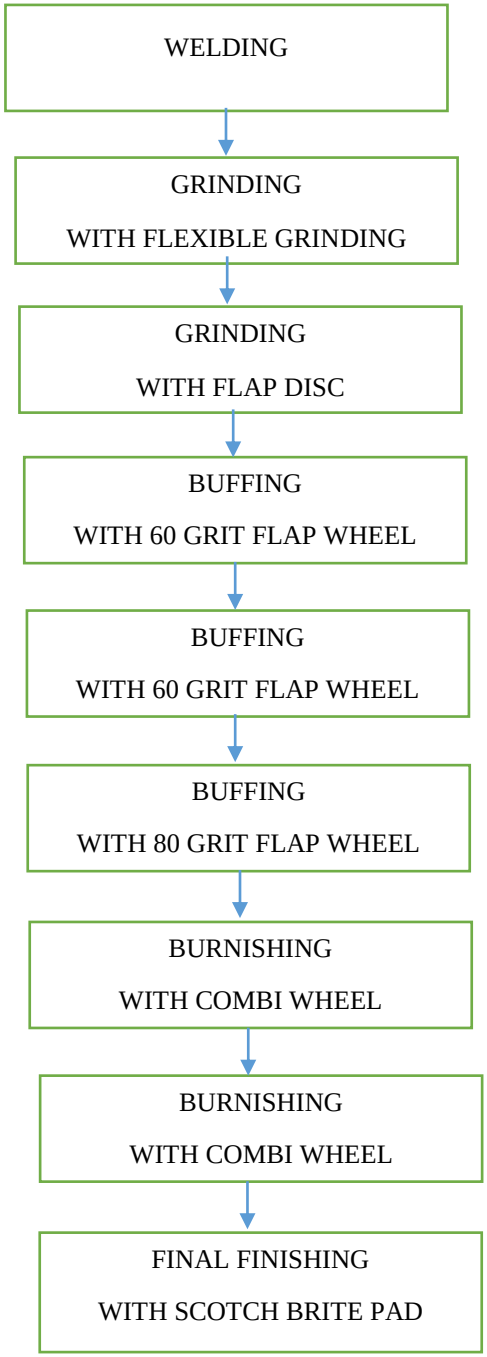
Mechanical finishing of stainless steel fabrication work is an essential step to optimize the benefits of using the material. Identifying the grit ("grain" can be used, but "grit" is more common) size of the abrasive for mechanical finishing operations is only a part of the specification process. When the aim is to precisely match an existing or intended finish, the best approach is to use comparative surface finish "swatch" samples. The fabricator or finishing contractor can only ensure that the required finish is produced if agreed samples are used as part of the specification process. Written descriptions (qualitative) or numeric (quantitative), e.g. R surface roughness figures, alone, are not sufficient to fully specify a mechanical finish on a stainless steel surface.

The correct choice of steel grade is also important from a surface finish point of view, especially when very smooth, highly reflective polished finishes are required. The most commonly used stainless grades for external applications are

EN 1.4301/1.4307 and, in more corrosive environments, EN 1.4401/1.4404. In some Countries and end-user segments, EN 1.4541 and 1.4571 are used as alternative grades for resistance against inter crystal line corrosion (instead of the low carbon grades 1.4307 and 1.4404 respectively). These two grades are alloyed with titanium and are less suitable for decorative polishing purposes, because they may result in an uneven look. When carrying out repair work on existing fabrications, these alternative grades, if offered by suppliers, should not be used as it may be difficult to match the existing finish.

Sr. no	Grade	Roughness value
1	2B	0.1-0.5
2	2J	0.2-1.0
3	2K	0.5-MAX

3.1 JOINT FINISHING METHOD



Here the diagram shows the complete flow of process which is used to prepare a joint which plays an important role in manufacturing of any of the tank. It is not the part of company drawn coil so we should take care for the stretching purpose.
Joint should be prepare in such a manner so that its surface looks similar to the other surface of tank. For that we are using different type of abrasive wheel which are listed bellow

- Flexible grinding disc
- Flap disc 60 Grit 4”
- Sander disc 80 & 20 Grit 7”
- Flap wheel 60 & 80 & 150 Grit
- Flap wheel 320 & 400 Grit (Mirror polish)
- Scotch hand pad.

The above listed method are too much time consuming and skilled labor required for performing the various operation apart from time consumption sometimes due to laziness of worker symmetric surface may not acquire in manual operation.so instead of manual operation semi-automatic or fully automatic system should be developed for small and medium scale industry. For semi-automatic system we can prepare a system for top and bottom dish finishing machine, in which dish can be mounted on bush which is attached with gear motor. So that mounted dish will rotate as the motor shaft rotates. At other side a worker will sit and keep a machine in hand. So due to rotation of dish at defined rpm the finishing will be more symmetric. Here the motor stand should be properly grouting so that so that due to weight of dish which is mounted on it will not collapse on work floor at the same situation where worker ‘s seat also properly fix so that during the operation worker does not collapse on rotating dish.

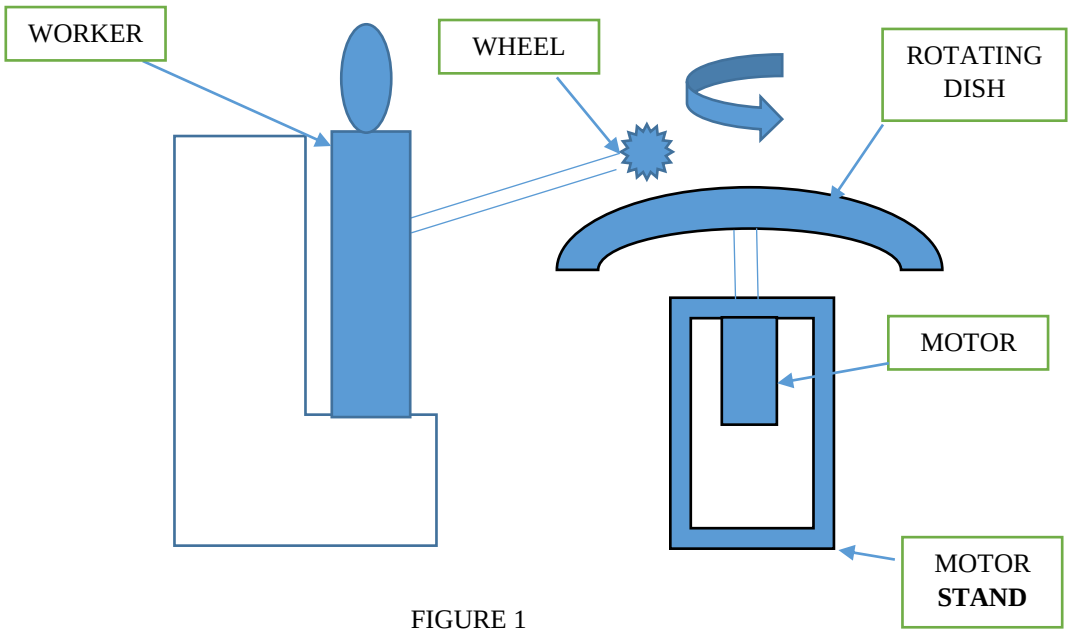


FIGURE 1

III. CONCLUSION

The paper gives the information about the procedure of tank manufacturing especially for milk storage purpose.it incudes the various operations used for manufacturing of tank and from that it concludes that it is very time consuming process so instead of performing manual operations we should design the technology which can provide the precise finish in less period of time it is only possible by implementation of the automation. Figure 1 shows the semi-automatic technology which we can implement for top and bottom dish of tank.so that overall manufacturing time will reduced and due to automation the quality of the work will increase. And if the manufactured product is going to use in pharmaceutical industries then the finishing must be done at automatic finishing machine. In pharmaceutical fermented tank and flow plate are required to be mirror polish and that can be easily achieved by automation.

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