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**Program for Design of Agitator / Mixerfor Vessels with Drawing**

I offer Design and Drawing program which Designs and Draws a detailed drawing of Agitator / Mixer, with user friendly dialog boxes, which is an add-on for any inexpensive CAD program like BricksCAD, ProgeCAD or ZWCAD program, for Designing and Developing GA drawing for Agitator / Mixer. The Program for Design and Drawing of Agitator / Mixer asks for some parameters and designs the basic parameters of agitator. It writes all these in a text file which can be submitted as design criteria. Program for Design and Drawing of Agitator / Mixer then draws the GA drawing and components. Program for Design and Drawing of Agitator / Mixer gives all minor details (even weight of each component and total weight) at Quotation Stage itself and this helps to quote in most competitive manner.

- Charges for Design and Drawing of Agitator: US$ 60 OR ₹ 4,000.
- Charges for Drawing of Agitator: US$ 30 OR ₹ 2,000.

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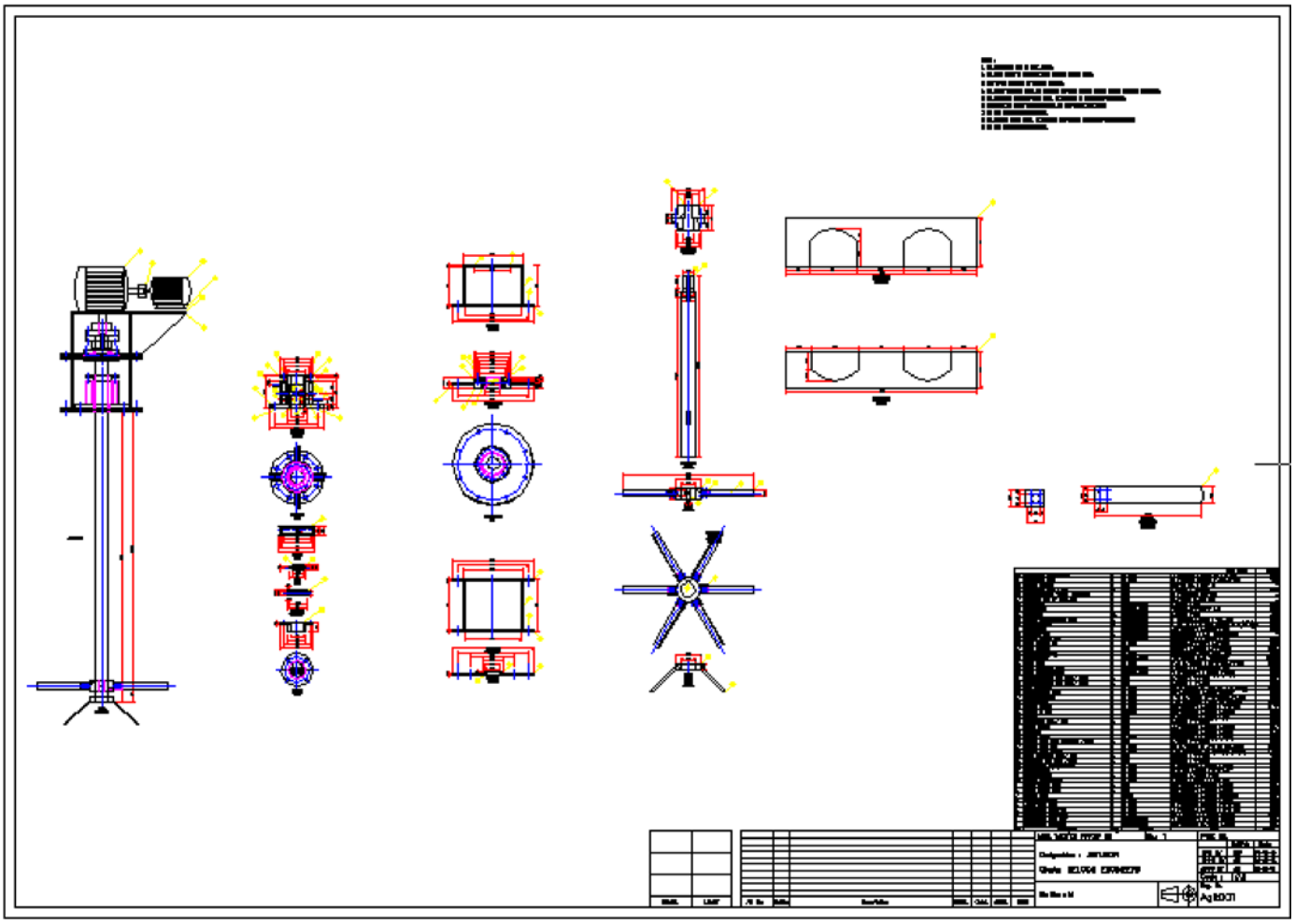
Information required for Design and Drawing of Agitator

1. Type of Tank: Vertical Cylindrical or Rectangular
2. For Vertical Cylindrical Tank: Diameter and length
3. For Rectangular Tank: Length, Width and height
4. Viscosity of Liquid in cP
5. Specific Gravity of liquid
6. Any preference for type of Impeller
7. Bearing Housing: Double, Single or none
8. Type of Mixing by Impeller: Axial flow or Radial Flow
9. Drive: Motor + Geabox or Geared Motor
10. RPM of shaft if specifically required
11. Material of Wetted Parts
12. Number of impellers: especially for long vessel
13. Impeller Blades: Bolted or Welded

14. Type of Seal: Mechanical Seal, Stuffing Box or none
15. Placement of Agitator: On top of vessel, On Channels (for open vessel)
16. Bottom Bearing (especially for long vessels)
17. Any Other

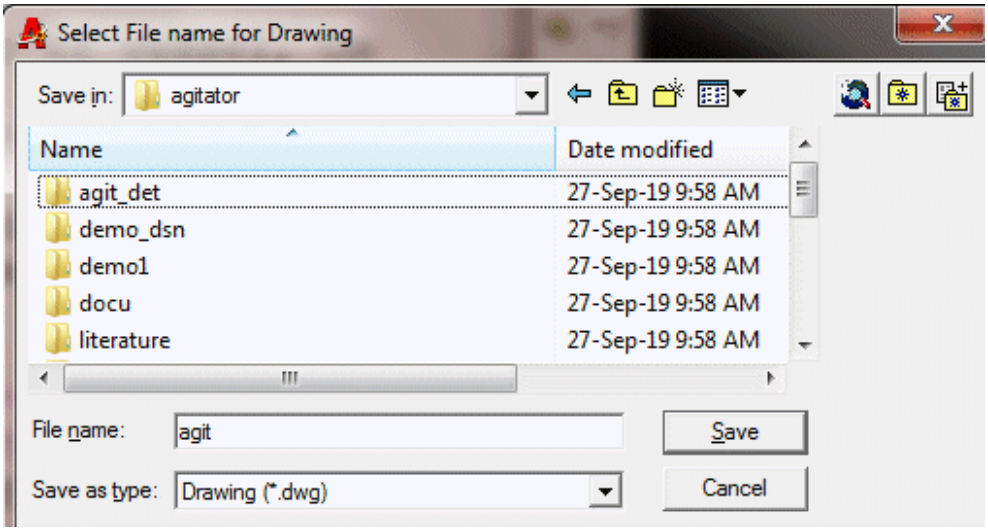
    Note : Program can not design and draw Fast Speed Mixers, helical screw mixers or mixers with hollow shaft.



Program for Design and Drawing of Agitator / Mixer will draw Drawing like this.

## How the Program for Design and Drawing of Agitator / Mixer Runs?

The Program for Design and Drawing of Agitator / Mixer asks for parameters in the following dialog boxes, and based on these values, designs and draws.




To run the program, unzip agit.zip and copy files in one folder on hard disk (and not on desk top), say agit. While running inexpensive CAD program like BricksCAD, ProgeCAD or ZWCAD program, click on tools ->Options (or Preferences) -> Files -> + of Support File Search Path -> Add -> Browse -> Select the folder (agit), and click on apply. The agit.zip file contains agit.lsp, agit.dcl and agit.slb, other lsp files, A1.dwg (Border drawing) and trial.dwg (dummy drawing). To run the program always open trial.dwg and load agit.lsp by appload or by typing (load "agit.lsp") at command prompt. (If you get message "File not found", please set up folder path settings again.) Type agit and press <enter> and program will start. The produced drawing can be saved in any folder you select and by the name you decide.
In a inexpensive CAD program like BricksCAD, ProgeCAD or ZWCAD Program, first open trial.dwg. It is a blank drawing. It is in the same folder where program files are located. It automatically defines the path (folder) to search the program files. At command prompt type (load "agit.lsp"). Agitator program will be loaded. Next type agit and press <enter>.The Program for Design and Drawing of Agitator / Mixer will ask for Drawing name and directory where it is to be stored.


You can draw either in Foot-Inch units or in Metric Units. In Metric system it asks for all values in millimeters and in Foot-inch systems it asks for all values in Foot-inch.

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You can design, create a drawing or exit/quit
If you select drawing option

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If you select Drawing option:


You can select the first tag number in this drawing. If this drawing is continuation of another drawing, first tag number will be the next number after the last number in earlier drawing.

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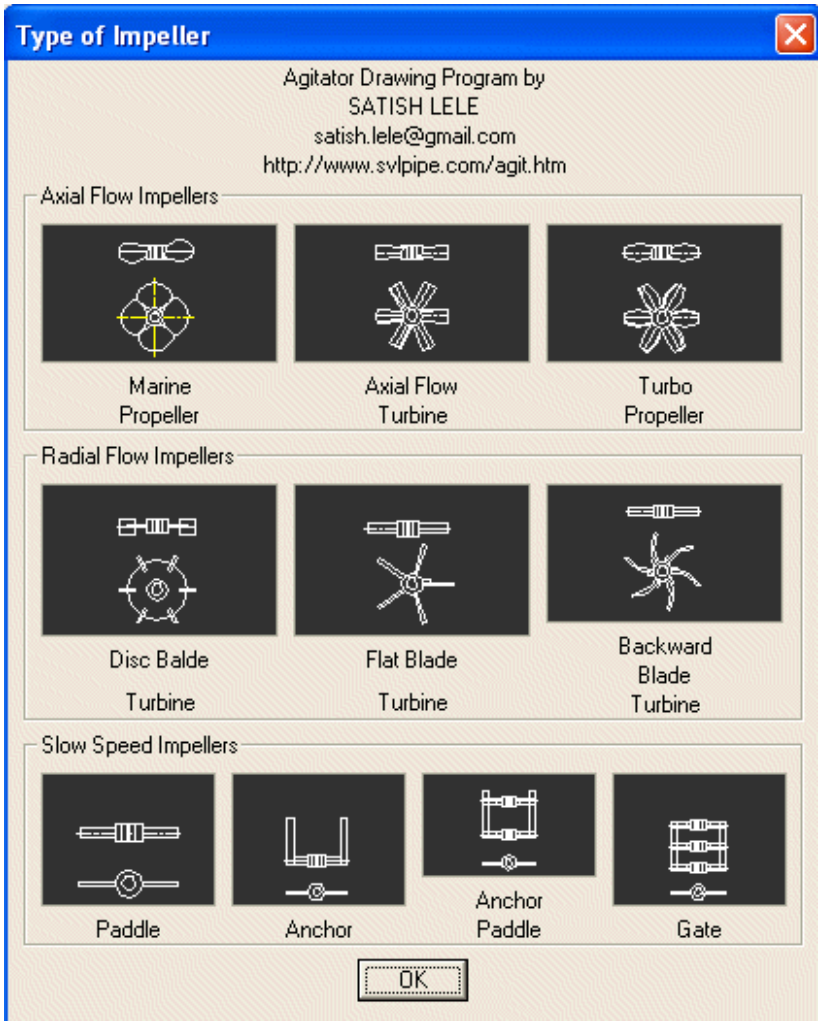
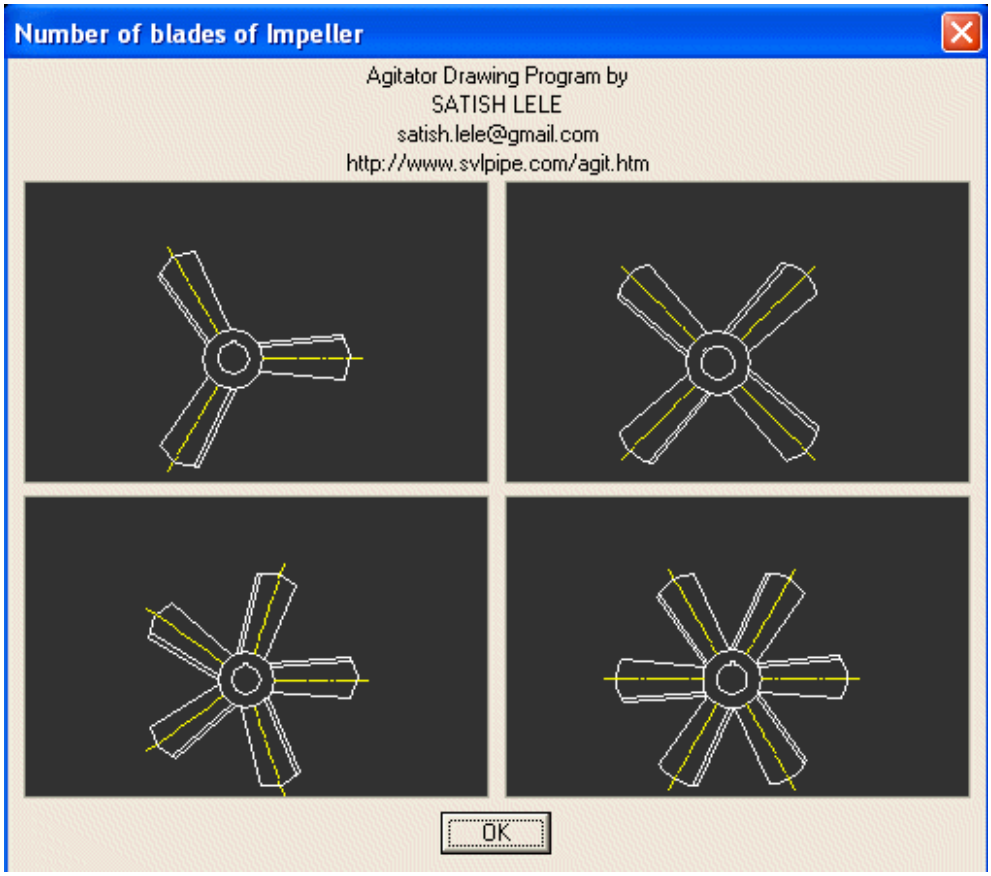



You can select the impeller.




For Marine Propeller you can select 3 or 4 blades. For Axial Flow Turbine, TurboProp, Flat Balde turbine and Disc Blade turbine you can select 3 to 6 blades. For Backward Blade Turbine you can select 2 to 6 blades. For Paddle, Anchor, Anchor/Paddle or Gate you can select only 2 blades.

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You can have a bottom bearing for shaft, if the shaft is very long. It effectively reduces shaft length to half for design calculations. Due to this shaft diameter is also reduced.

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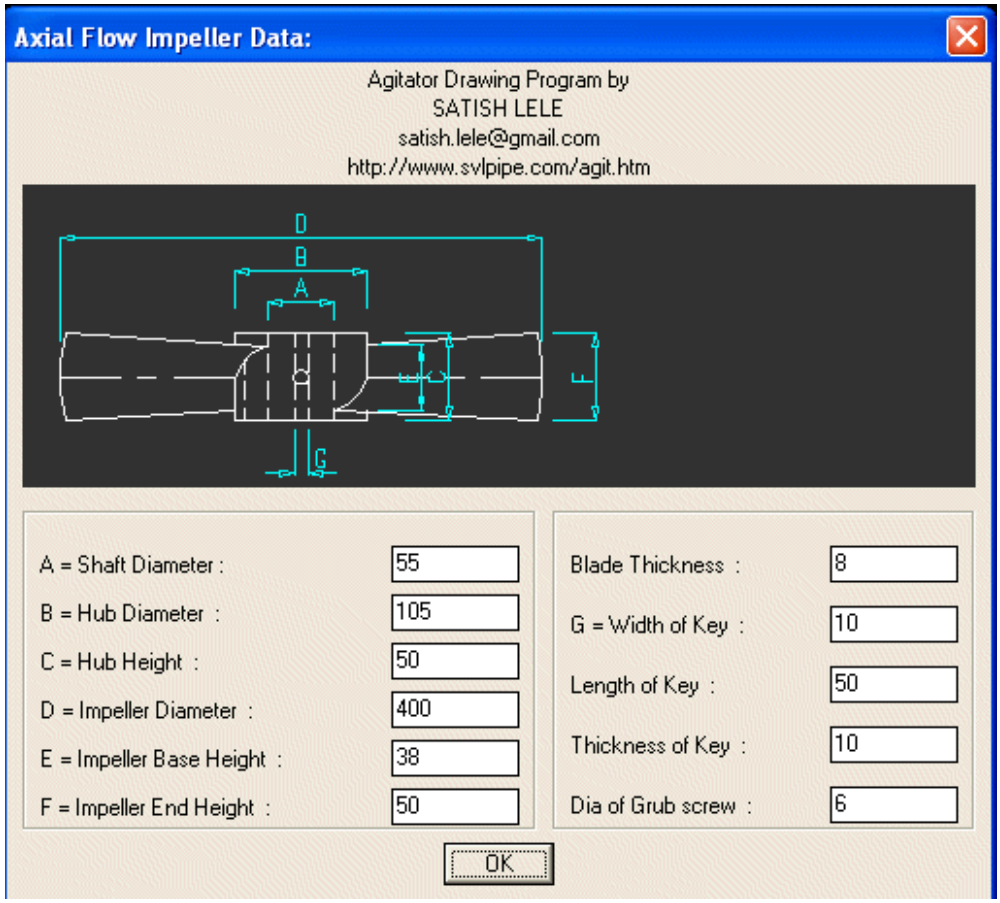
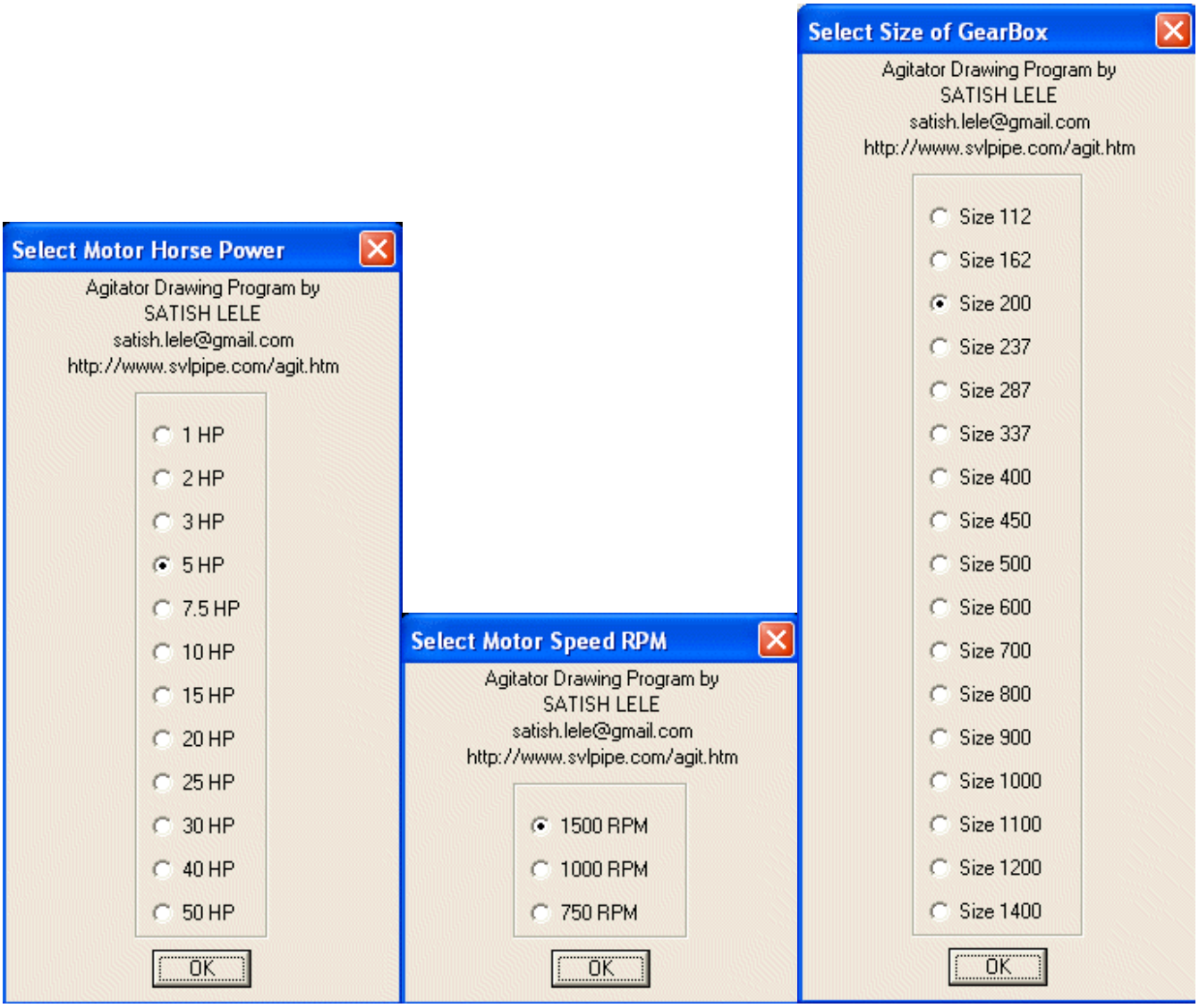



Program automatically calculates all the demensions and shows in this table. You can accept the same or change sizes for parts of Impeller.




Program for Design and Drawing of Agitator / Mixer shows recommended HP of motor, RPM of motor and size of gearbox. You can select Horse Power of Motor, Speed (RPM) of Motor and size of gearbox. If you have selected Geared motor you need not select RPM and gearbox size.

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Program for Design and Drawing of Agitator / Mixer shows best possible combination based on rotational speed of agitator and gear ratio of gearbox.

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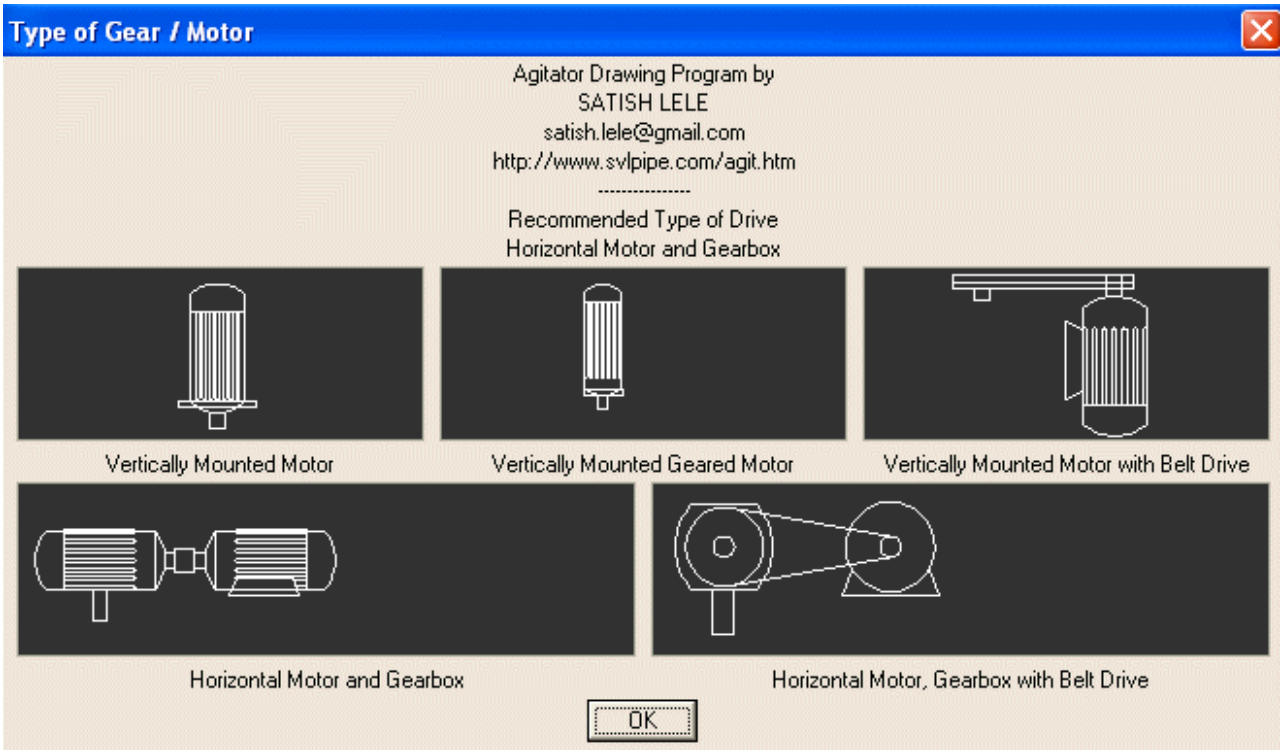


You can still select the Drive unit.

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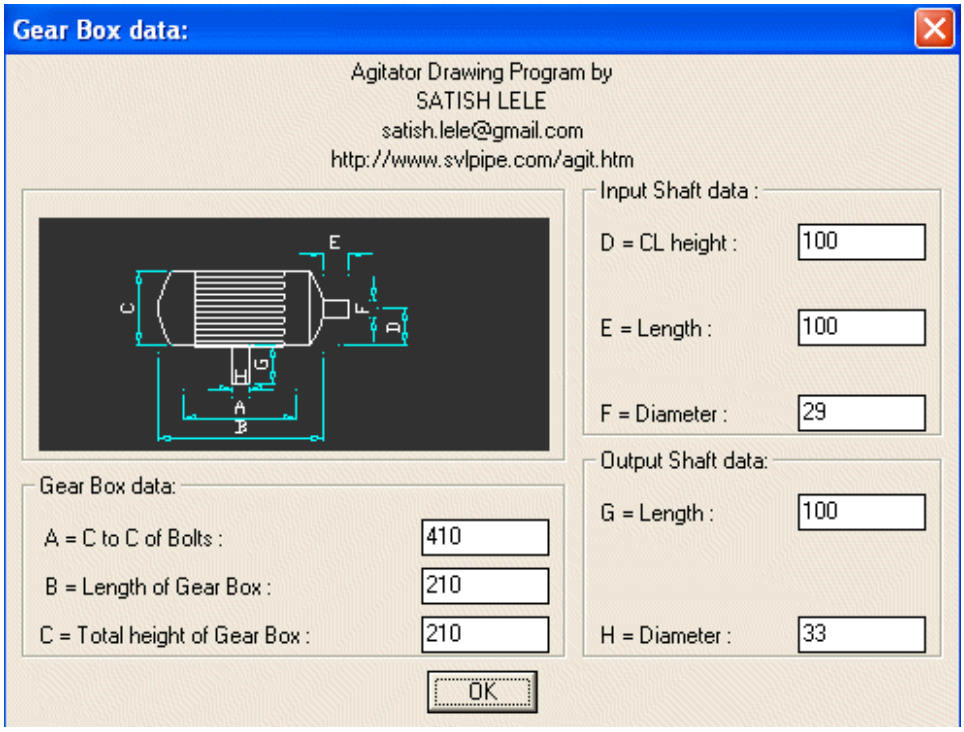


You can select sizes for parts of Gear Box. The default values are based on standard gearboxes.

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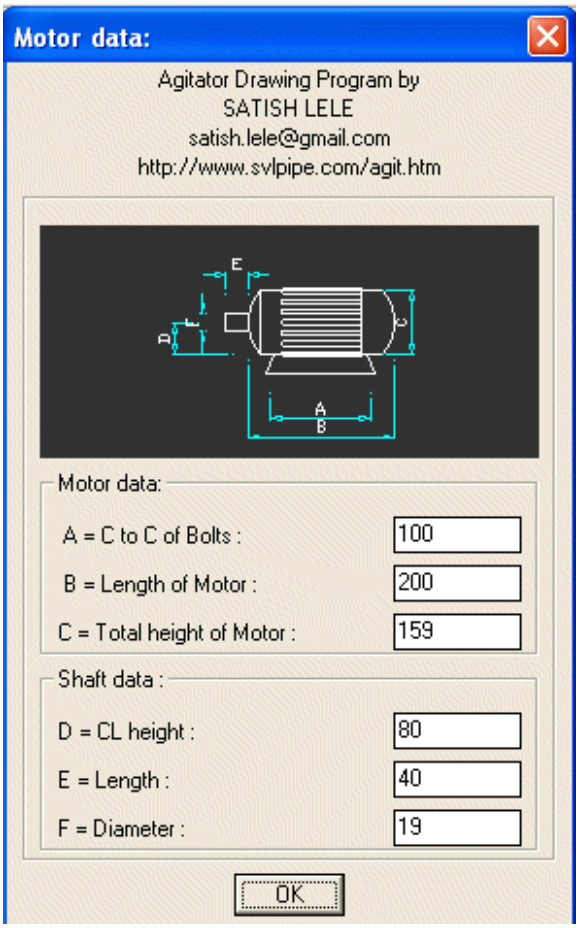
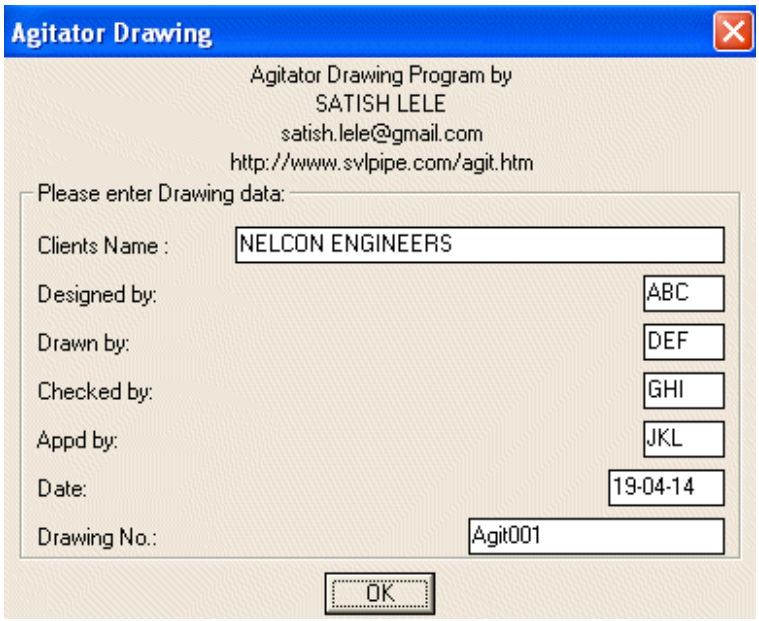
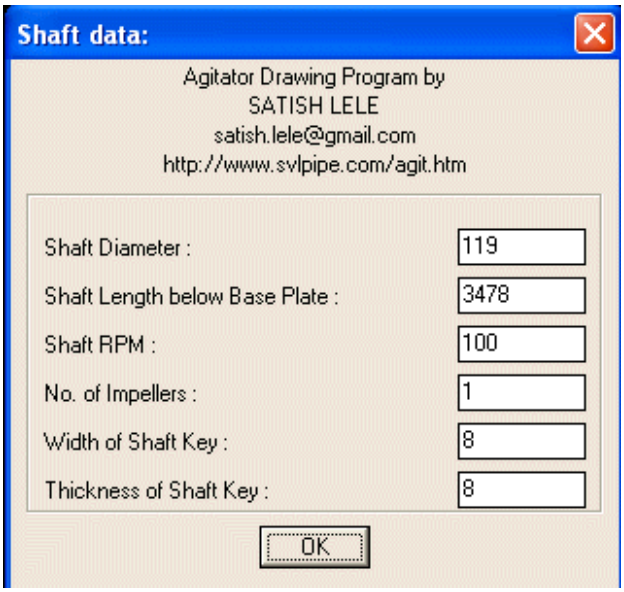



You can select sizes for parts of Motor. The default values are based on standard motors,

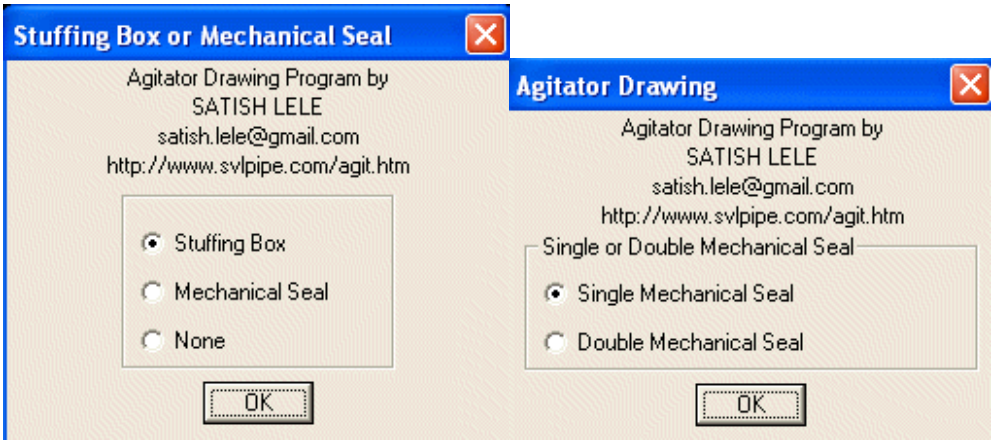



You can enter the data generally entered in Title Block. Current date is automatically displayed. You can enter drawing number. The drawing will be

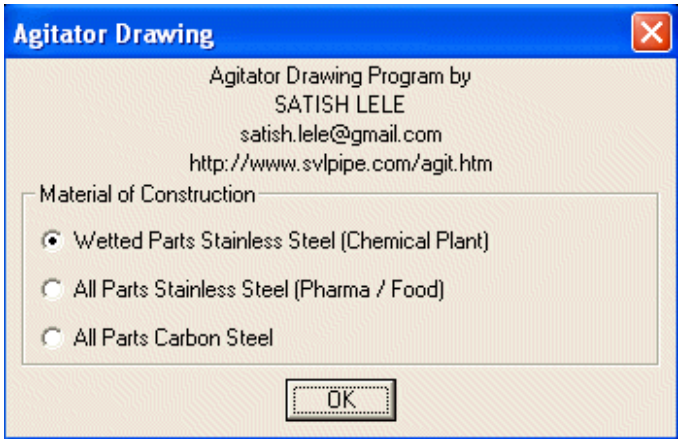
saved with this number.




If diameter and length of shaft is calculated by process design calculations, diameter and length of shaft will be automatically indicated. You can round up diameter and length of shaft.




You can select either Stuffing Box, Mechanical seal or without any seal. If you select Mechanical Seal, you can select Single or Double Mechanical Seal.




You can select Material of construction for wetted parts. Material of construction can be All Parts of Stainless Steel, Wetted Parts Stainless Steel or All Parts of Carbon Steel. SS liner will be provided on CS base plate if wetted parts are SS.

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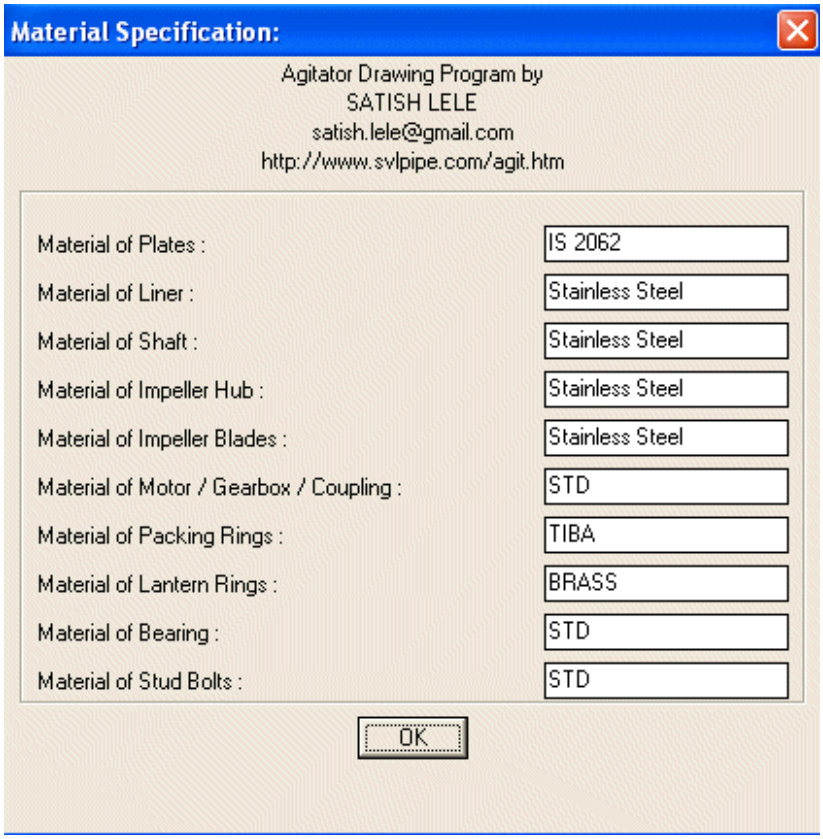


If you select Stuffing Box, Program indicates appropriate material of construction for parts. You can select / modify material for all parts. If you select Mechanical Seal, Program indicates appropriate material of construction for parts. You can select / modify material for all parts.

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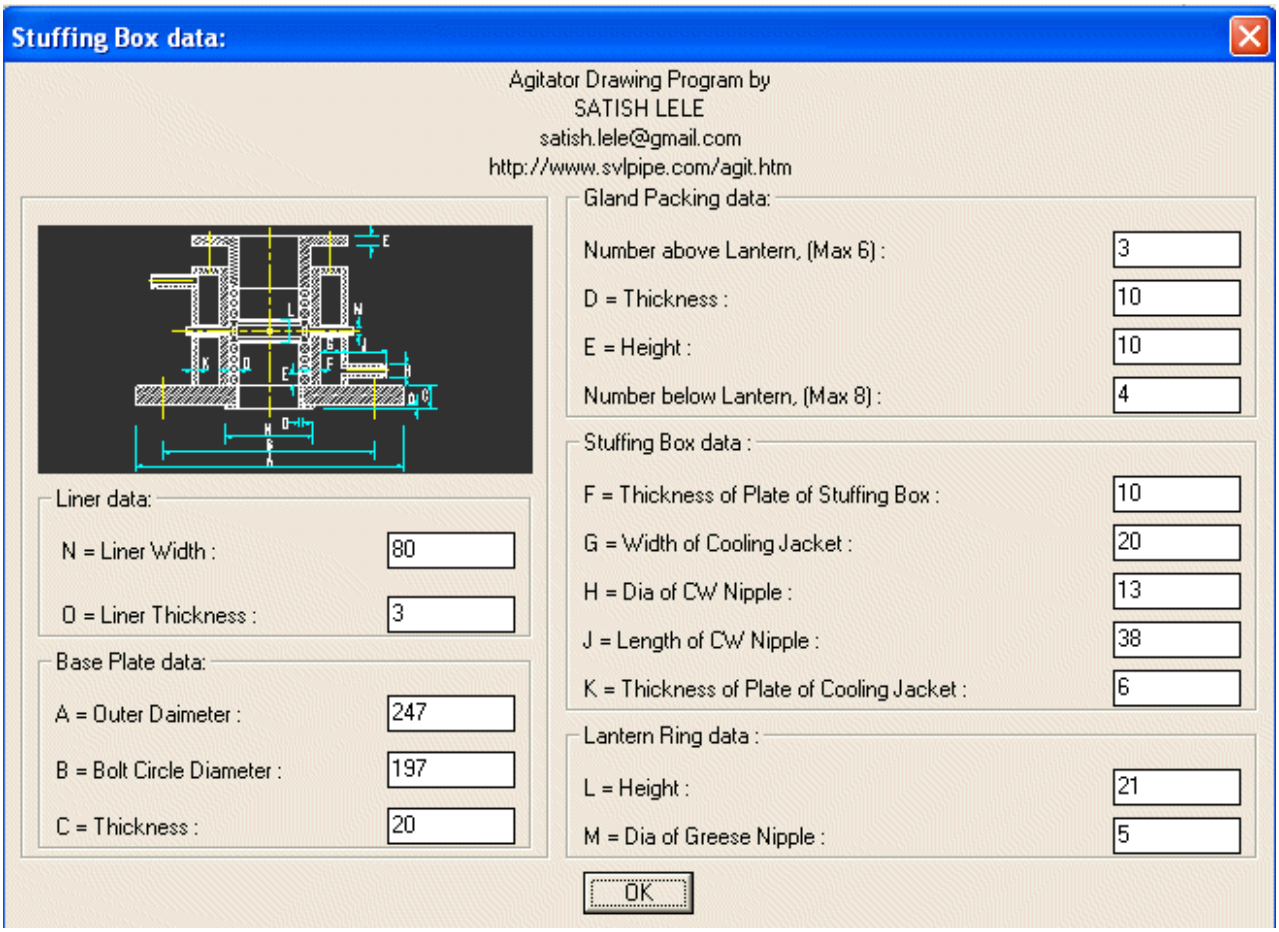
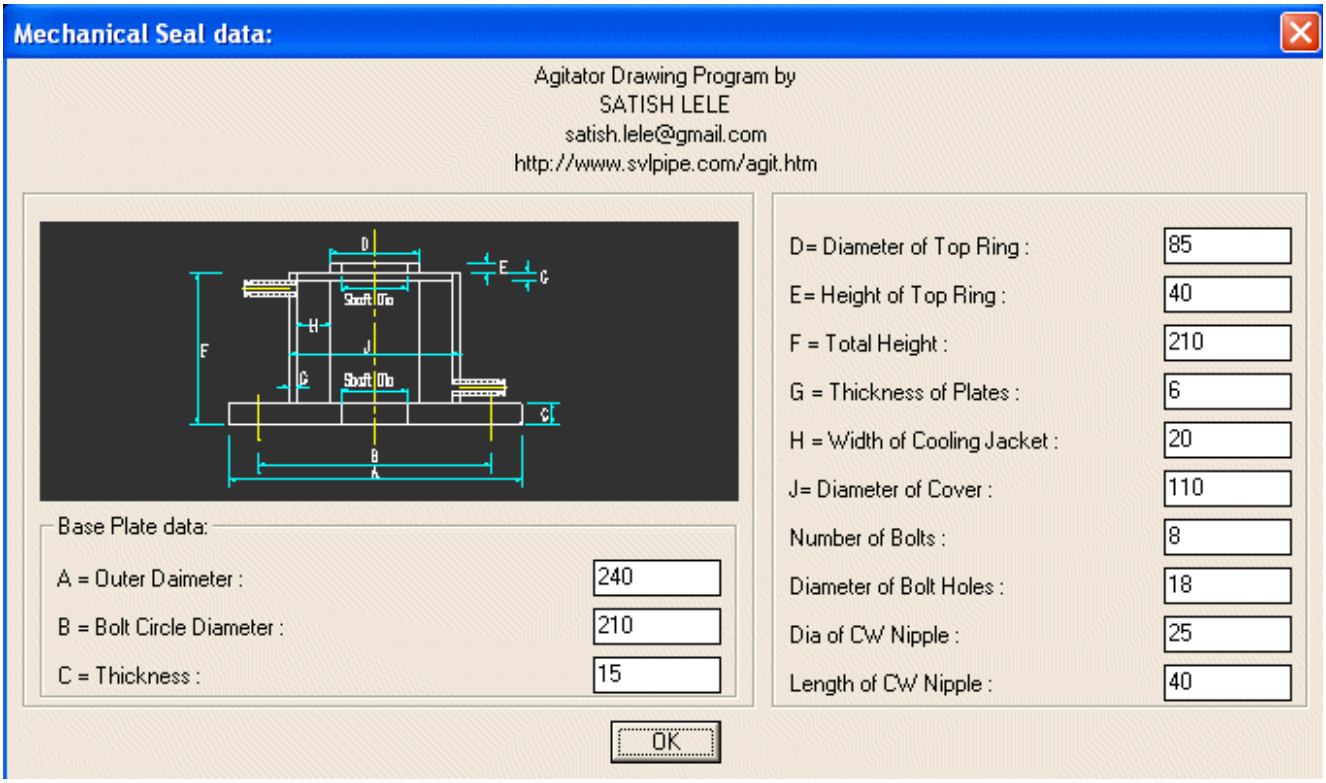
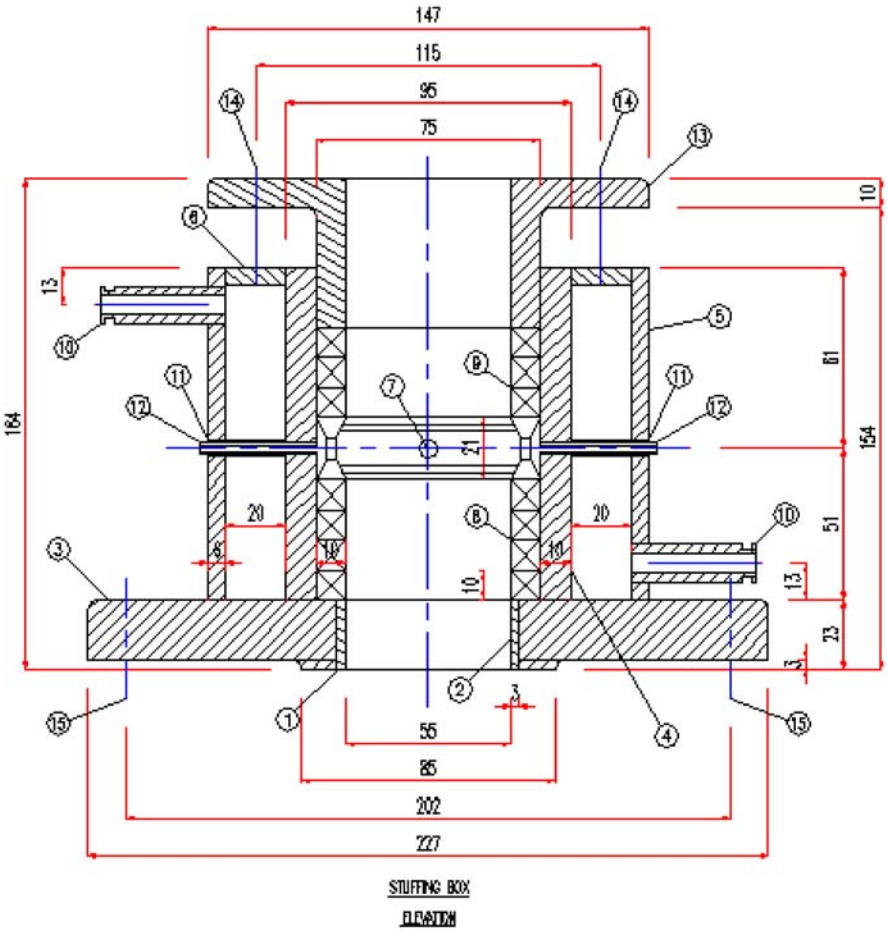


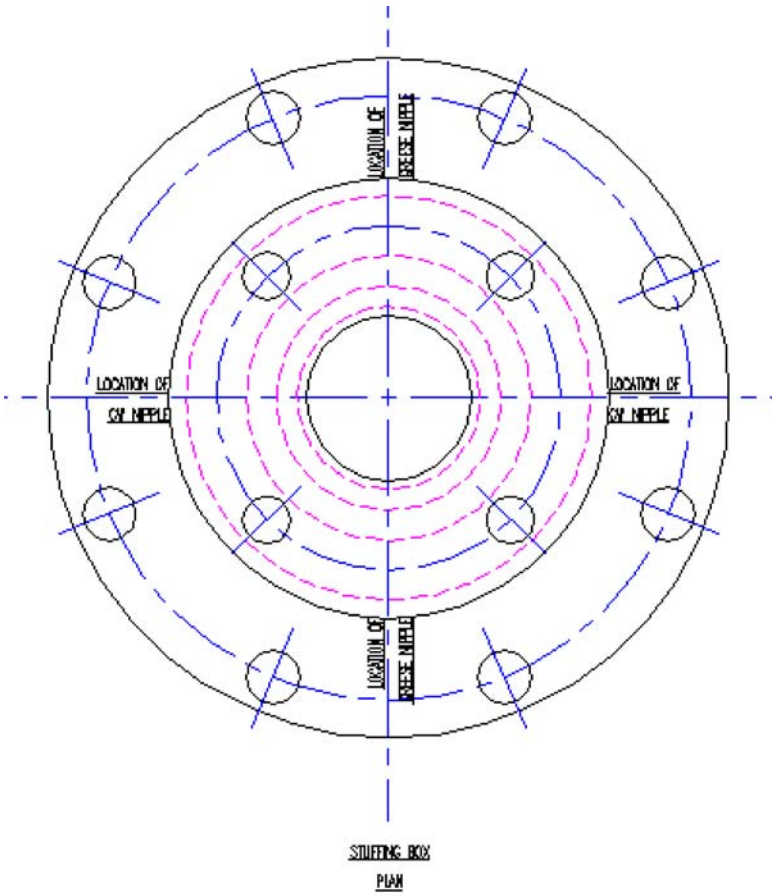

If you select Stuffing Box, with respect to diameter of shaft, all the dimensions for Stuffing Box will be calculated and indicated by Program for Drawing of Agitator / Mixer. You can change any value.




If you select Mechanical Seal, with respect to diameter of shaft, all the dimensions for Mechanical Seal will be calculated and indicated by Program for Drawing of Agitator / Mixer. You can change any value.




It draws Elevation of Stuffing Box. It shows all the dimensions.




Under elevation it draws Plan of Stuffing Box.

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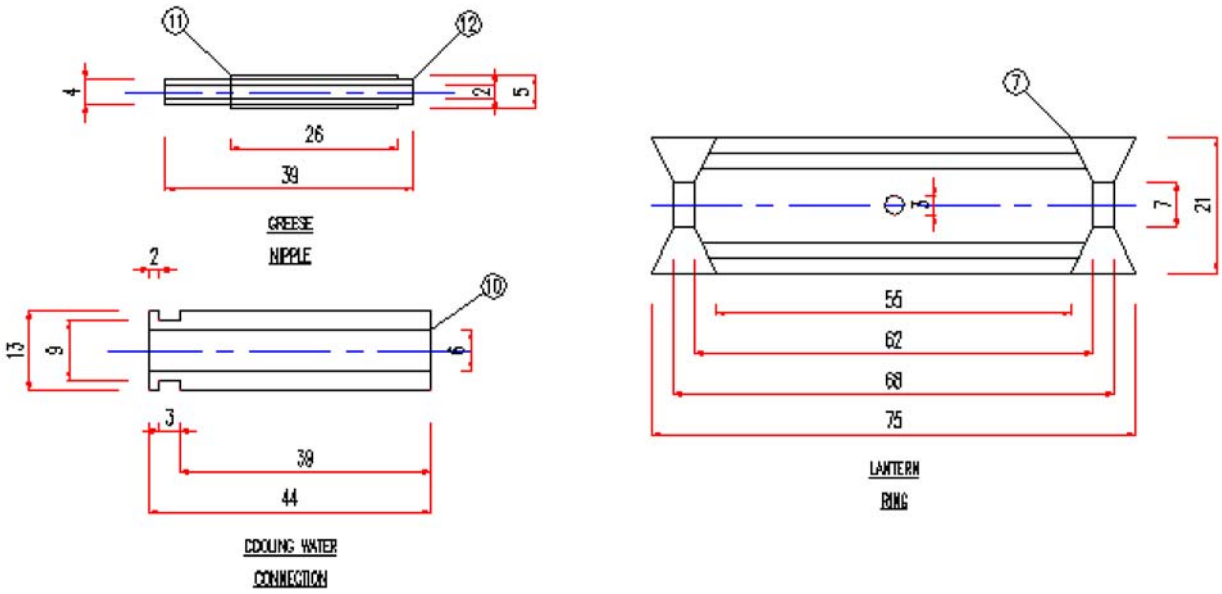


Details of smaller parts of Stuffing Box.

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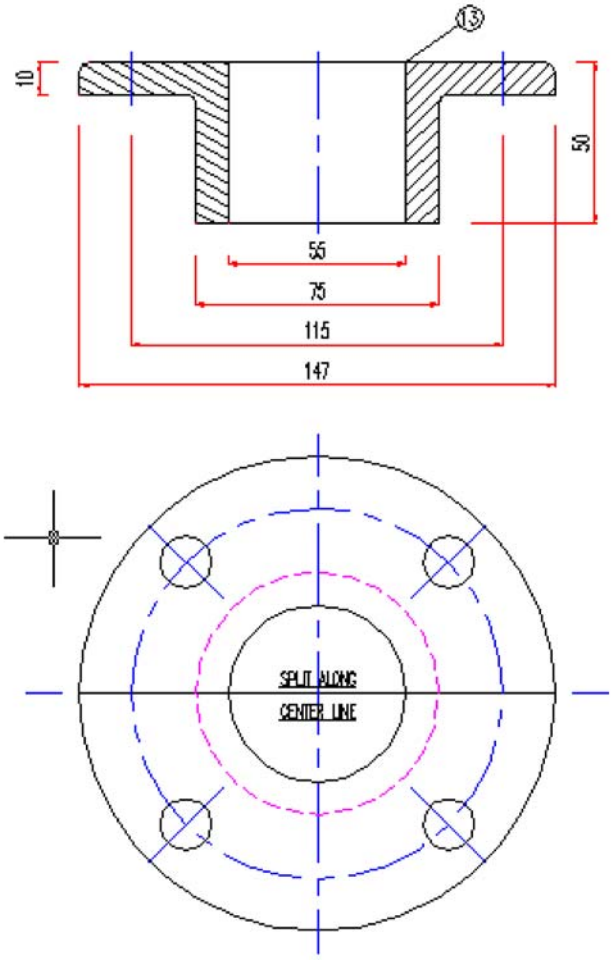
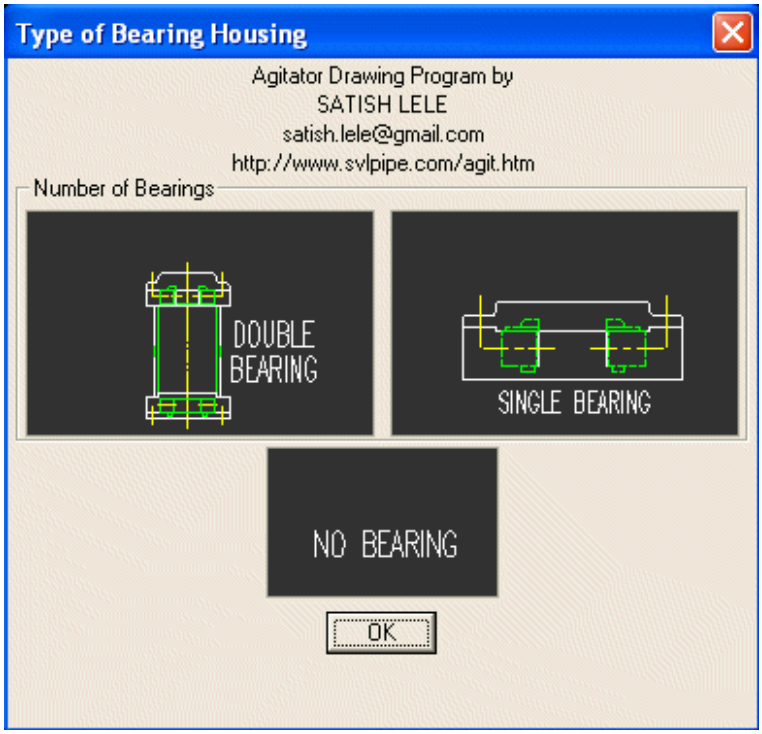



Elevation and Plan of top pressure ring.

| No | Description | Qty | Material | Size | Wt Kgs |
|---|---|---|---|---|---|
| 15 | Base Plate Stud Bolts / Nuts | 8 | STD | 16(Dia) 39(Lg) | 0.52 |
| 14 | Top Cover Stud Bolts / Nuts | 4 | STD | 16(Dia) 39(Lg) | 0.26 |
| 13 | Stuffing Box Top Split Cover | 2 | CS | 147(OD) 55(ID) 20(Lg) | 3.04 |
| 12 | Greese Nipples | 2 | CS | 4(OD) 2(ID) 39(Lg) | 0.01 |
| 11 | Greese Nozzles | 2 | CS | 5(OD) 4(ID) 26(Lg) | 0.00 |
| 10 | Cooling Water Nozzles | 2 | CS | 13(OD) 6(ID) 42(Lg) | 0.06 |
| 9 | Upper Packing Rings | 3 | TIBA | 75(OD) 55(ID) 10(Ht) | 0.06 |
| 8 | Lower Packing Rings | 4 | TIBA | 75(OD) 55(ID) 10(Ht) | 0.08 |
| 7 | Lantern Ring | 1 | BRASS | 75(OD) 55(ID) 21(Th) | 0.35 |
| 6 | Jacket Cover Plate | 1 | CS | 135(OD) 95(ID) 6(Th) | 0.35 |
| 5 | Jacket Shell Plate | 1 | CS | 147(OD) 135(ID) 111(Lg) | 2.40 |
| 4 | Stuffing Box Shell Plate | 1 | CS | 95(OD) 75(ID) 111(Lg) | 2.42 |
| 3 | Stuffing Box Base Plate | 1 | CS | 227(OD) 55(ID) 20(Th) | 6.21 |
| 2 | Stuffing Box Shaft Liner | 1 | SS | 61(OD) 55(ID) 23(Lg) | 0.10 |
| 1 | Stuffing Box Base Liner | 1 | SS | 85(OD) 61(ID) 3(Th) | 0.07 |

Bill of material for the parts of Stuffing Box.




You can select type of Bearing Housing. Bearing Housing can be made up of 2 bearings or only 1 bearing. You can also have a shaft without any bearing on shaft.

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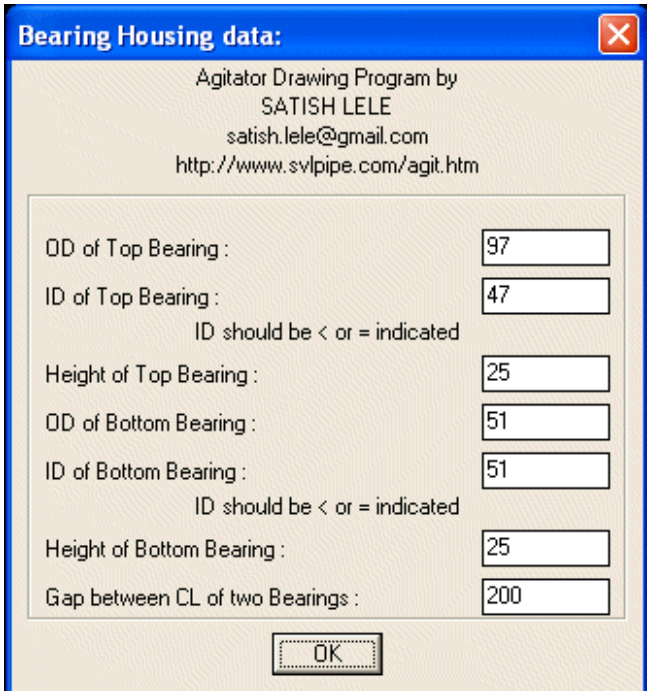


For a bearing housing having 2 bearings, all the dimensions will be calculated and indicated by Program for Design and Drawing of Agitator / Mixer. You may change some of these.

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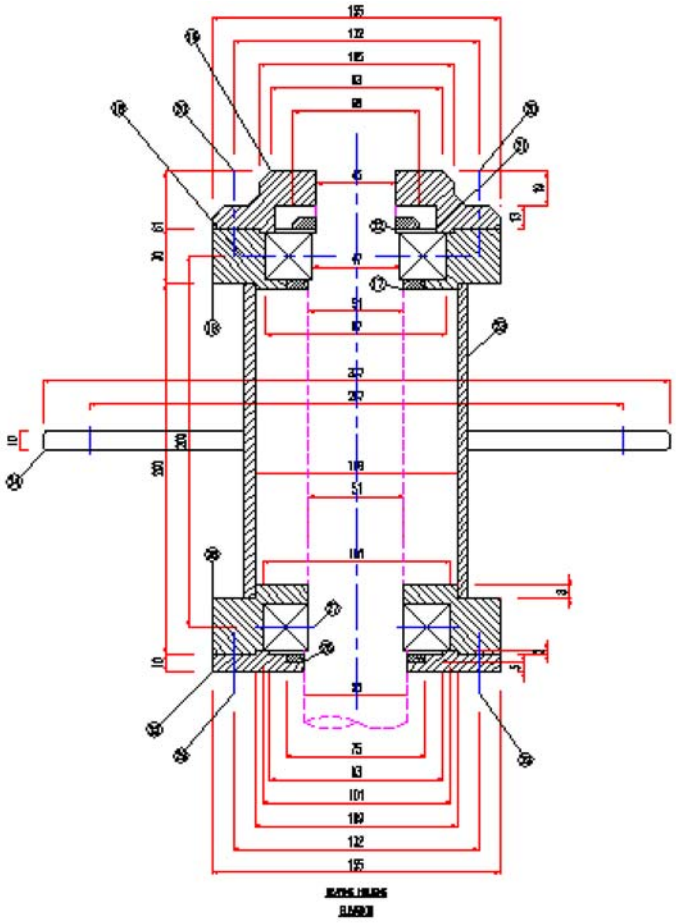
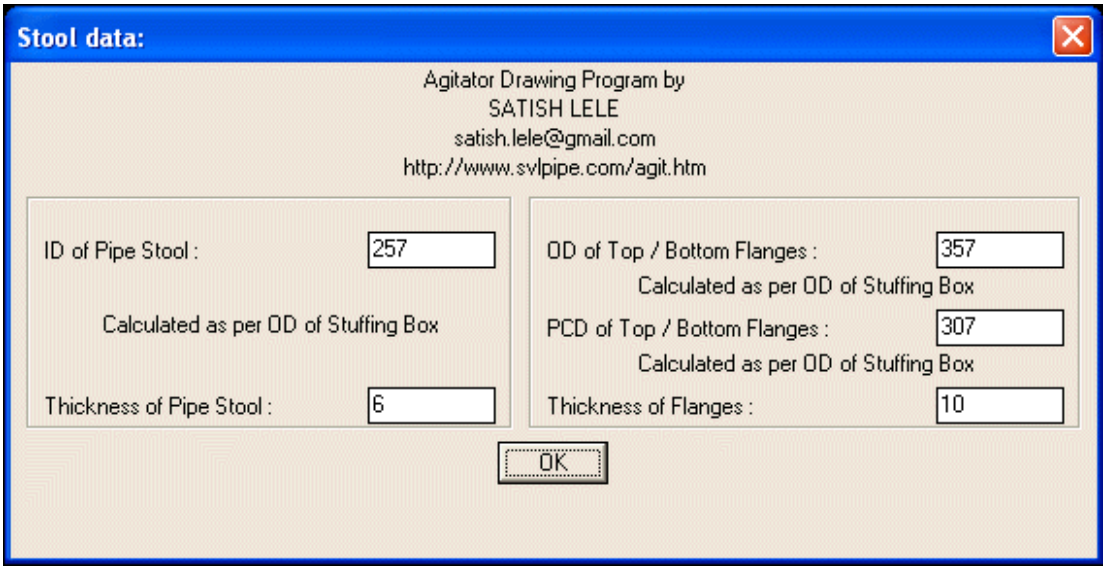
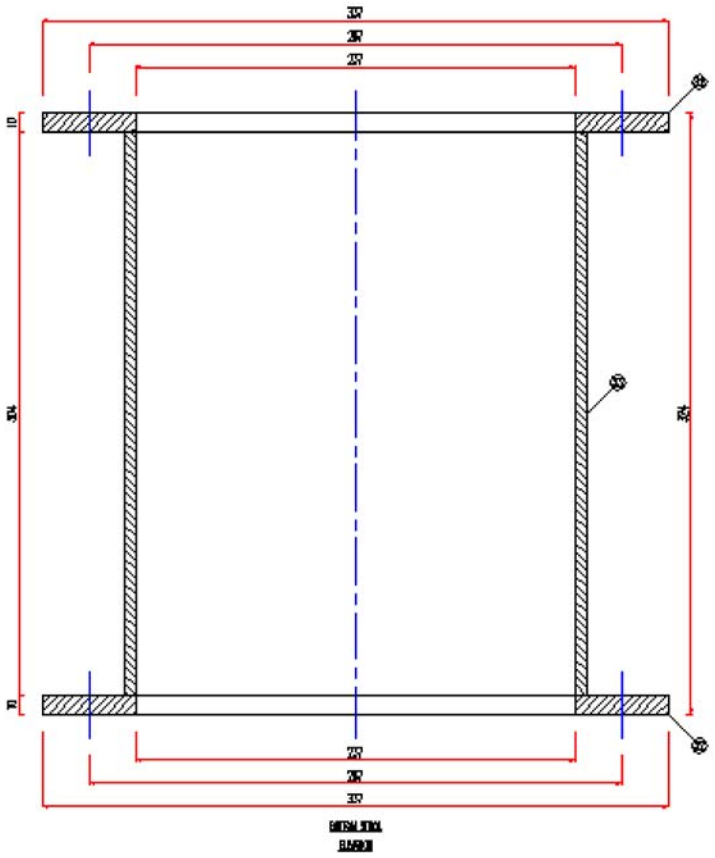


Double Bearing Housing Assembly.



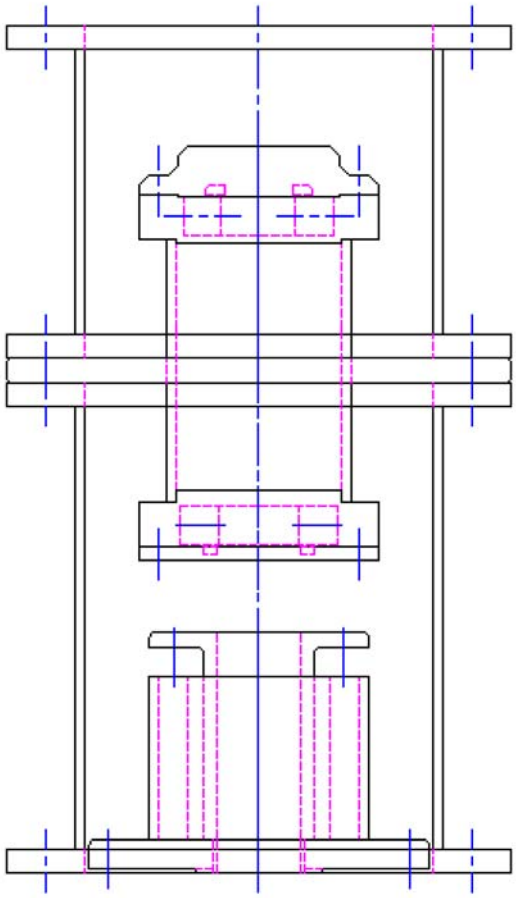

The dimensions of top and bottom stool will be calculated and indicated by Program for Design and Drawing of Agitator / Mixer. You may change or round up some of these.



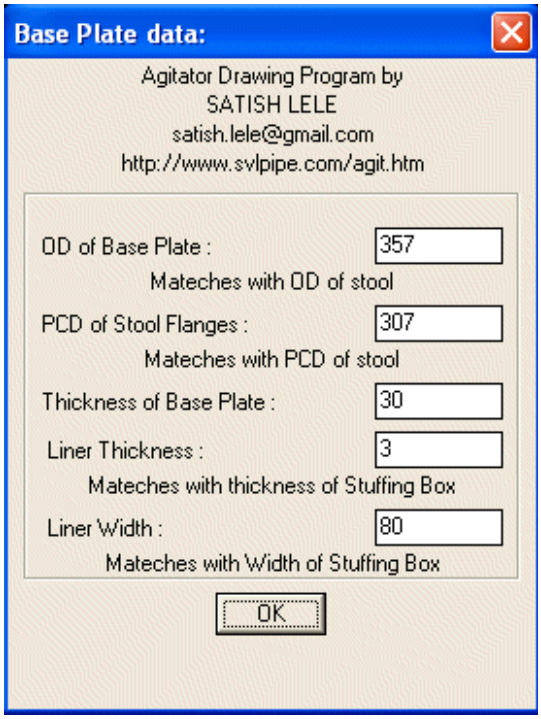
Drawing of Stool.

| | | | | | |
|---|---|---|---|---|---|
| | | | | Total Weight | 76.18 |
| 33 | Bottom Stool Shell | 1 | CS | 249(OD) 237(ID) 304(Lg) | 11.35 |
| 32 | Bottom Stool Flanges | 2 | CS | 337(OD) 237(ID) 10(Th) | 7.35 |
| 31 | Top Stool Shell | 1 | CS | 249(OD) 237(ID) 190(Lg) | 7.09 |
| 30 | Top Stool Flanges | 2 | CS | 337(OD) 237(ID) 10(Th) | 7.35 |
| 29 | Lower Cover Stud Bolts / Nuts | 4 | STD | 6(Dia) 33(Lg) | 0.03 |
| 28 | Lower Bearing Casing | 1 | CS | 155(OD) 51(ID) 37(Th) | 5.08 |
| 27 | Lower Bearing | 1 | STD | 101(OD) 51(ID) 25(Ht) | 1.22 |
| 26 | Lower Bearing O Ring | 1 | RUBBER | 75(OD) 55(ID) 5(Th) | 0.01 |
| 25 | Lower Bearing Cover | 1 | CS | 155(OD) 55(ID) 10(Th) | 1.34 |
| 24 | Support Ring | 1 | CS | 337(OD) 121(ID) 10(Th) | 6.33 |
| 23 | Bearing Casing Channel | 1 | CS | 121(OD) 109(ID) 170(Th) | 3.00 |
| 22 | Lock Nut | 1 | CS | 68(OD) 43(ID) 3(Th) | 0.06 |
| 21 | Spring Washer | 1 | CS | 87(OD) 43(ID) 2(Th) | 0.07 |
| 20 | Top Cover Stud Bolts / Nuts | 4 | STD | 6(Dia) 46(Lg) | 0.04 |
| 19 | Top Bearing Casing | 1 | CS | 155(OD) 51(ID) 30(Th) | 4.05 |
| 18 | Top Bearing | 1 | STD | 97(OD) 47(ID) 25(Ht) | 1.15 |
| 17 | Top Bearing O Ring | 1 | RUBBER | 75(OD) 51(ID) 5(Th) | 0.01 |
| 16 | Top Bearing Cover | 1 | CS | 155(OD) 43(ID) 33(Th) | 4.72 |
| No | Description | Qty | Material | Size | Wt. Kgs |

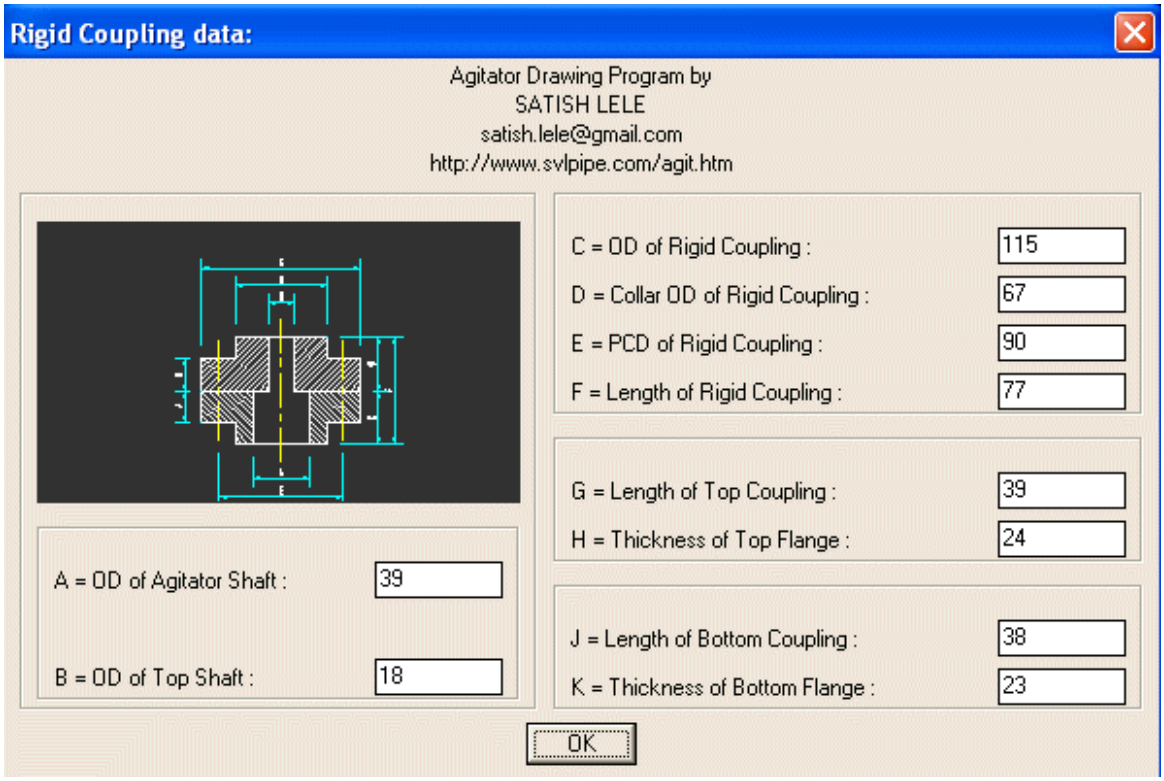
Bill of material for the parts of Bearing Housing and Stool.



Assembly of Stuffing Box, Bearing Housing, and Top and Bottom Stools.




You can select sizes for Base Plate. You may change or round up some of these.




You can select sizes for Rigid Coupling.

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In trial mode of Program for Design and Drawing of Agitator / Mixer, you can select values of Radio Button, Image Buttons, Check Boxes and List box, but you can not change values in Edit Boxes.

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The dialog boxes in Design mode are different.


Program for Design and Drawing of Agitator / Mixer, program asks for type of vessel (Vertical Cylindrical or Rectangular).

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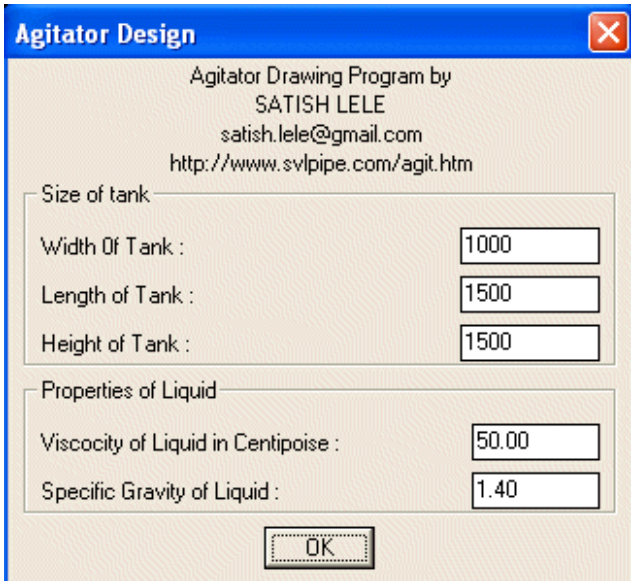
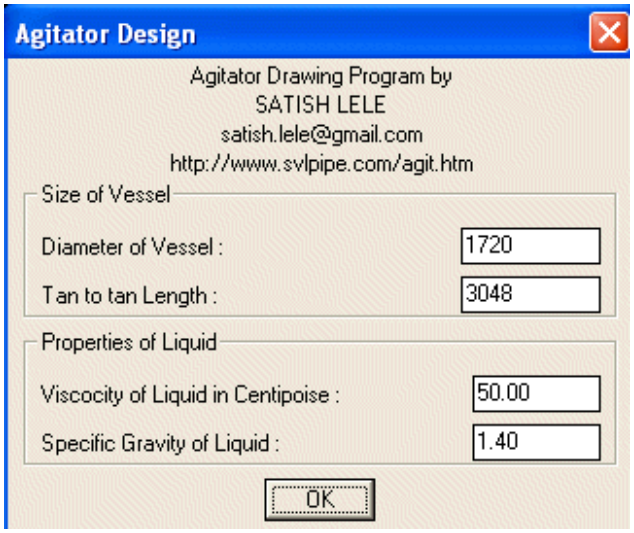
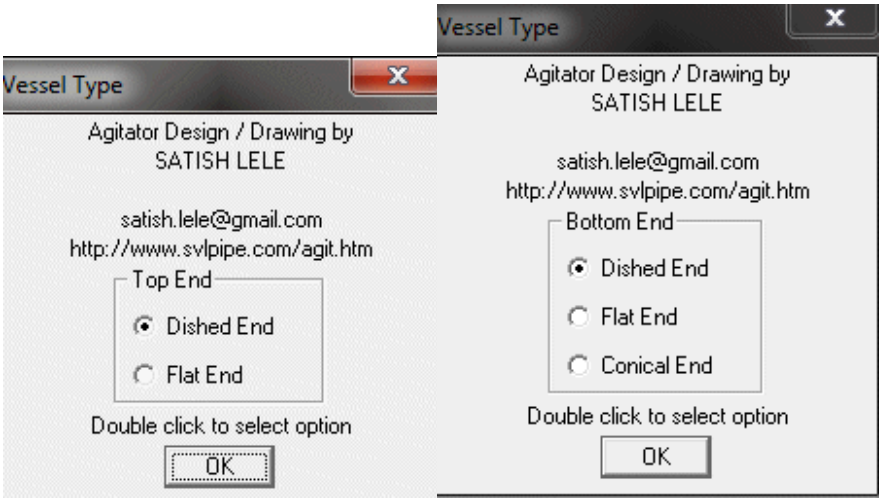



Program for Design and Drawing of Agitator / Mixer asks for size of Rectangular tank, Width, Length and Depth, and properties of liquid.

OR




Program for Design and Drawing of Agitator / Mixer asks for Diameter and Tan to Tan Length of vessel and properties of liquid.




Next it asks for head at top and bottom end: Flat, conical or Torispherical.

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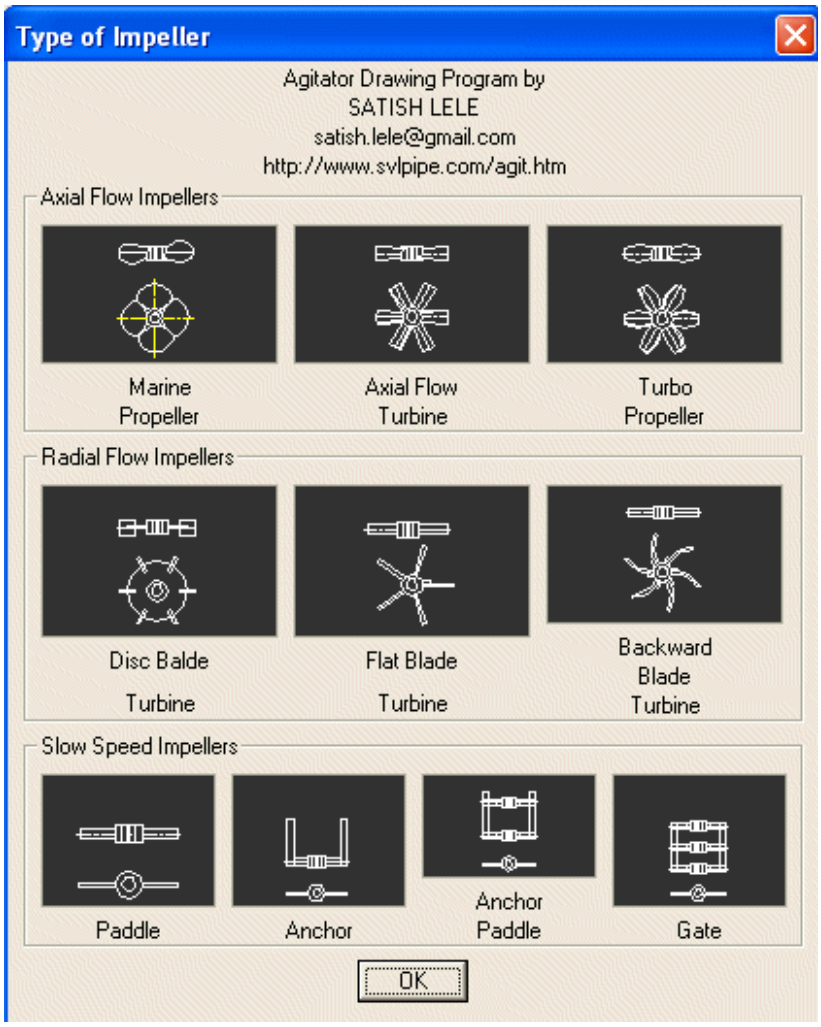


It asks you to select type of Imeller.

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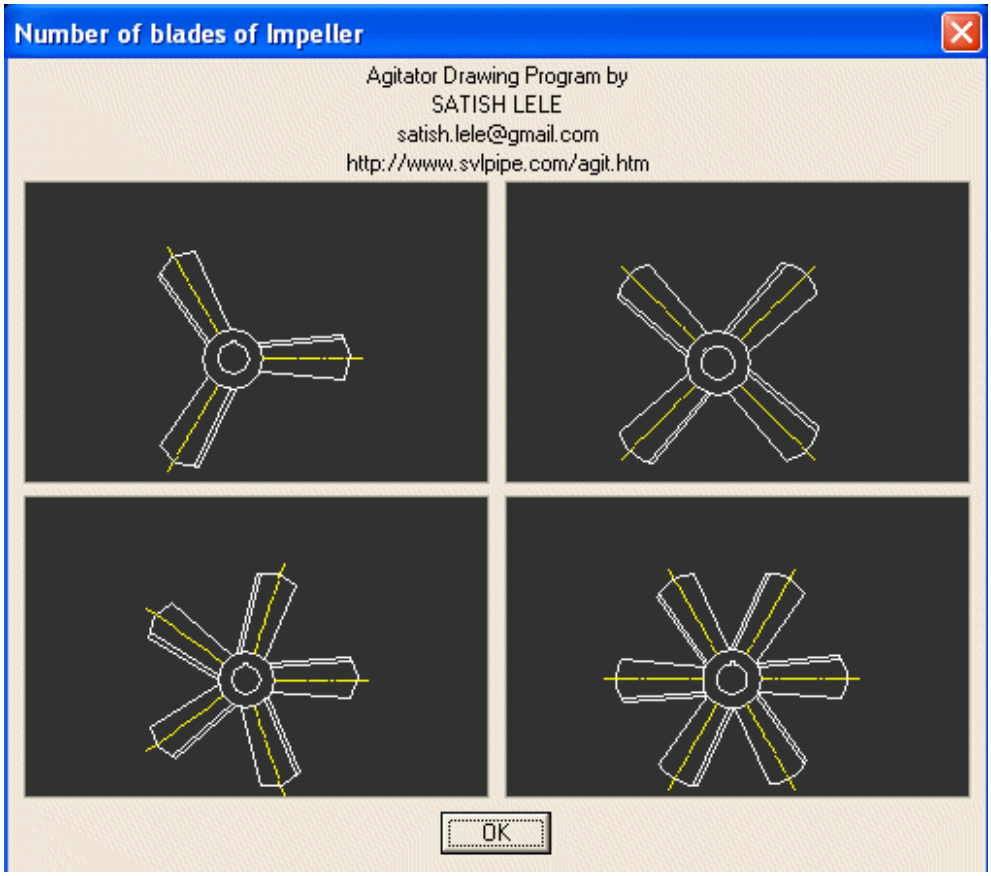


It asks you to select number of blades of Impeller. For Marine Propeller you can select 3 or 4 blades. For Axial Flow Turbine, TurboProp, Flat Balde turbine and Disc Blade turbine you can select 3 to 6 blades. For Backward Blade Turbine you can select 2 to 6 blades. For Paddle, Anchor, Anchor/Paddle or Gate you can select only 2 blades.

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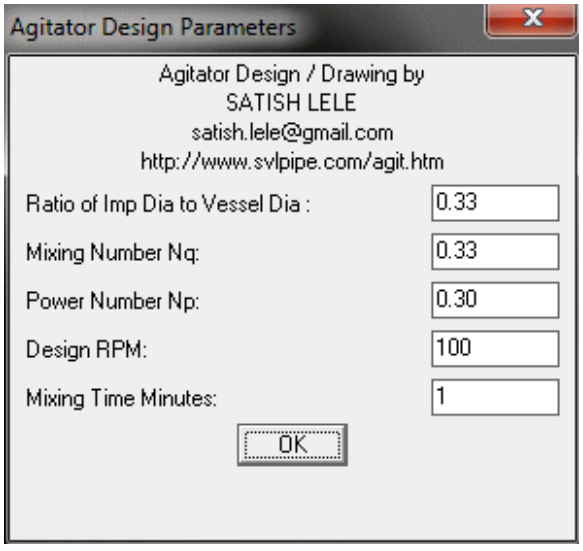
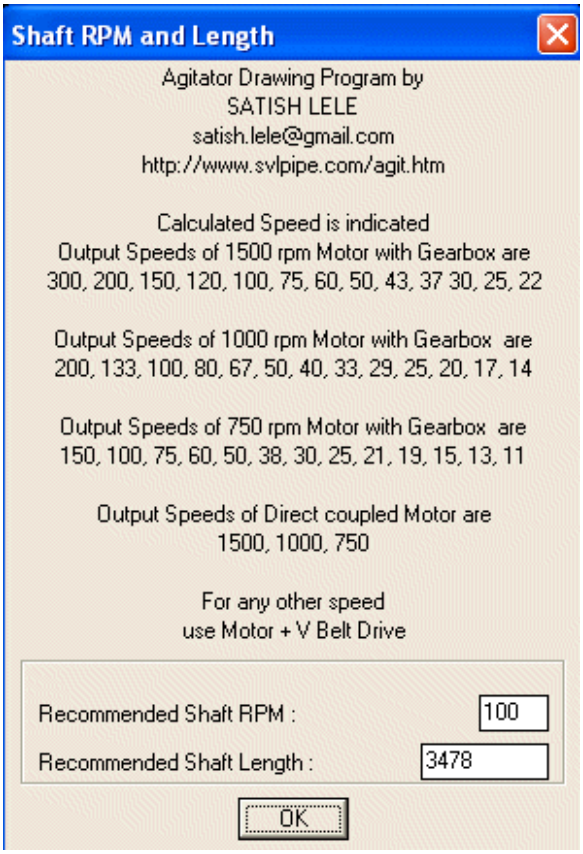
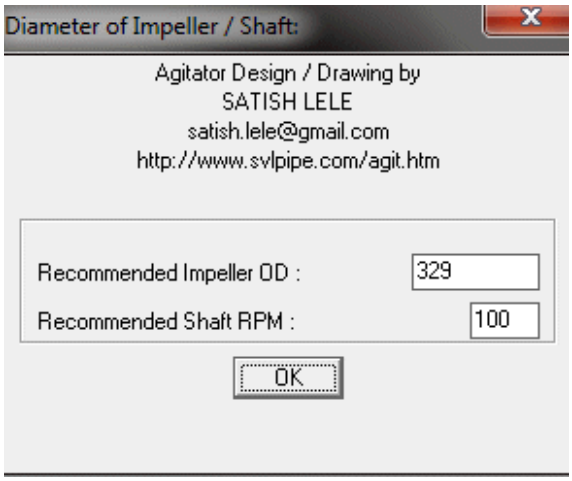



It shows properties of particular impeller. You can change Design RPM and Mixing time. Mixing time decides the Pumping rate of impeller. If mixing

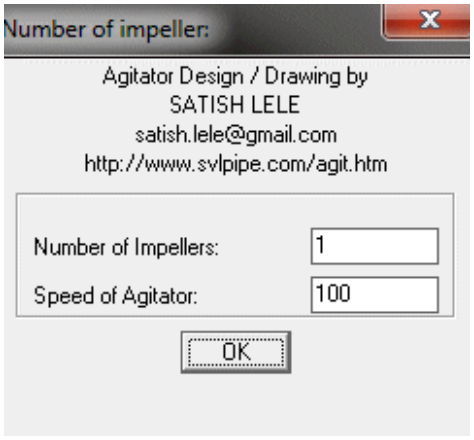
required is vigourous, mixing time should be small. If mild mixing is required mixing time should be high. Entire content of the vessel will be mixed in so many minutes.




Based on Reynold's number and ratio of Impeller dia to Vessel dia, program for Design and Drawing of Agitator / Mixer calculates the desired rotational speed of agitator. Program for Design and Drawing of Agitator / Mixer also calculates length of shaft inside vessel and indicates length of shaft.

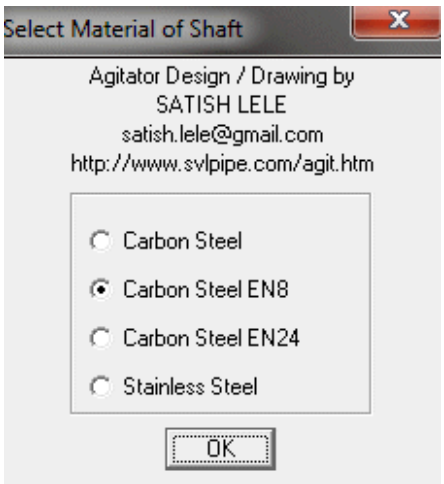


The program shows recommended impeller OD and RPM. Yoy can round up OD.

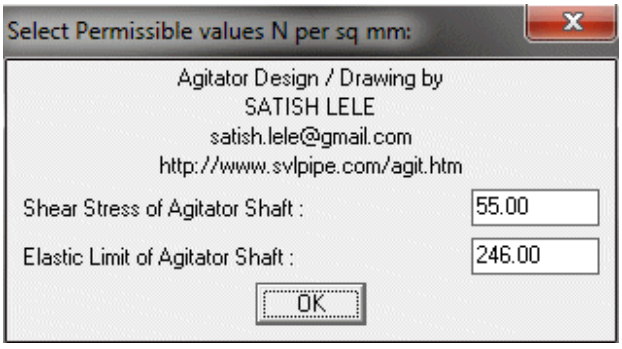



Program asks for number of impellers and cornfirm RPM.

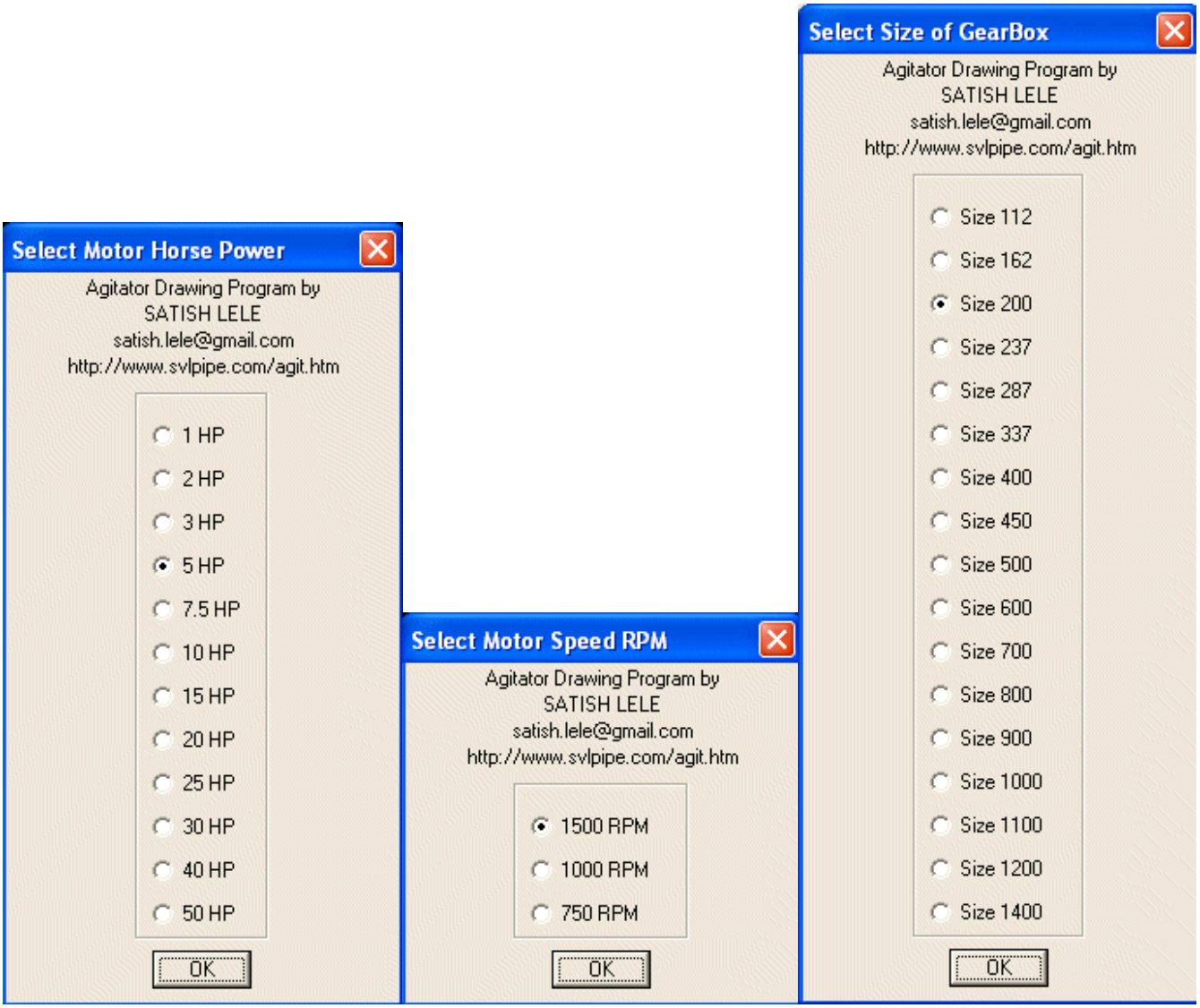

Program ask for safety factor for the shaft.



Program for Design and Drawing of Agitator / Mixer then asks for material of construction for shaft.

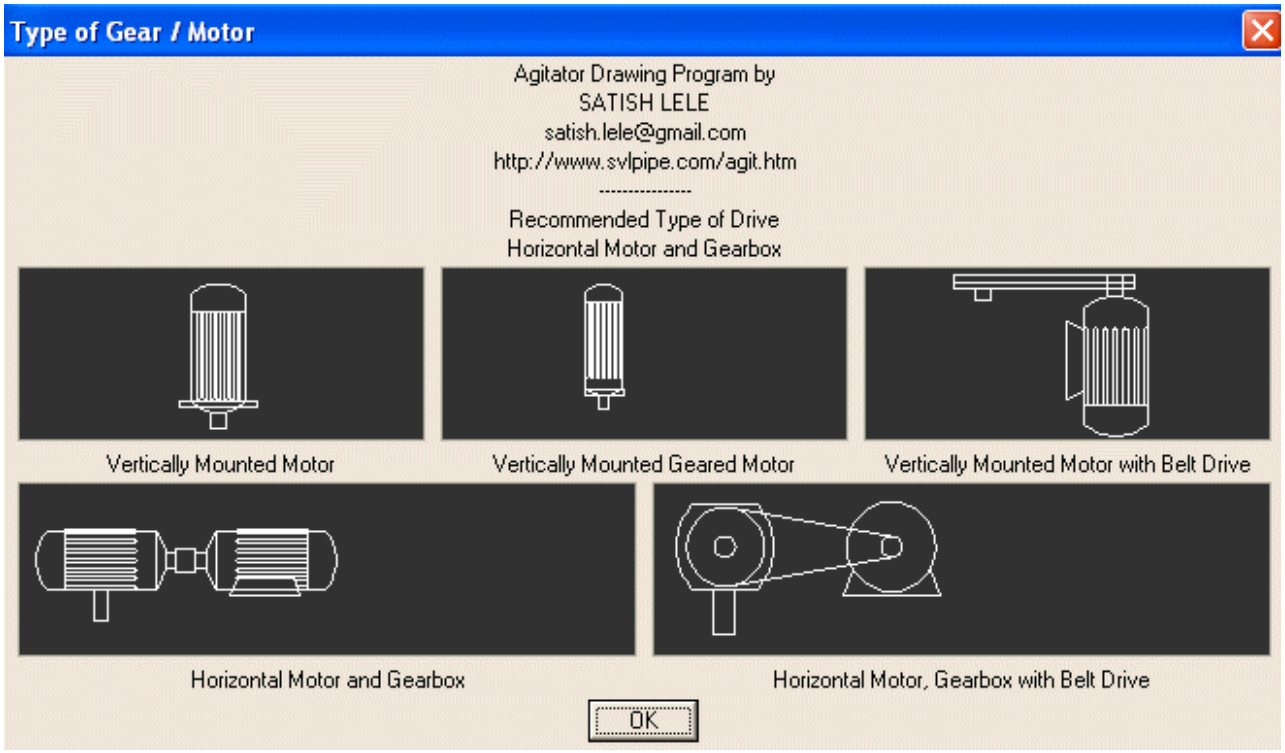



Program ask for Shear Stress and Eleastic limit for the shaft. Values for the shaft material are automatically filled in.



Program for Design and Drawing of Agitator / Mixer shows recommended HP of motor, RPM of motor and size of gearbox. You can select Horse Power of Motor, Speed (RPM) of Motor and size of gearbox. If you have selected Geared motor you need not select RPM and gearbox size.


Program for Design and Drawing of Agitator / Mixer shows best possible combination based on rotational speed of agitator and gear ratio of gearbox.




You can still select the Drive unit.


You can have a bottom bearing for shaft, if the shaft is very long. It effectively reduces shaft length to half for design calculations. Due to this shaft diameter is also reduced.

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Program shows final values that will be used for drawing.

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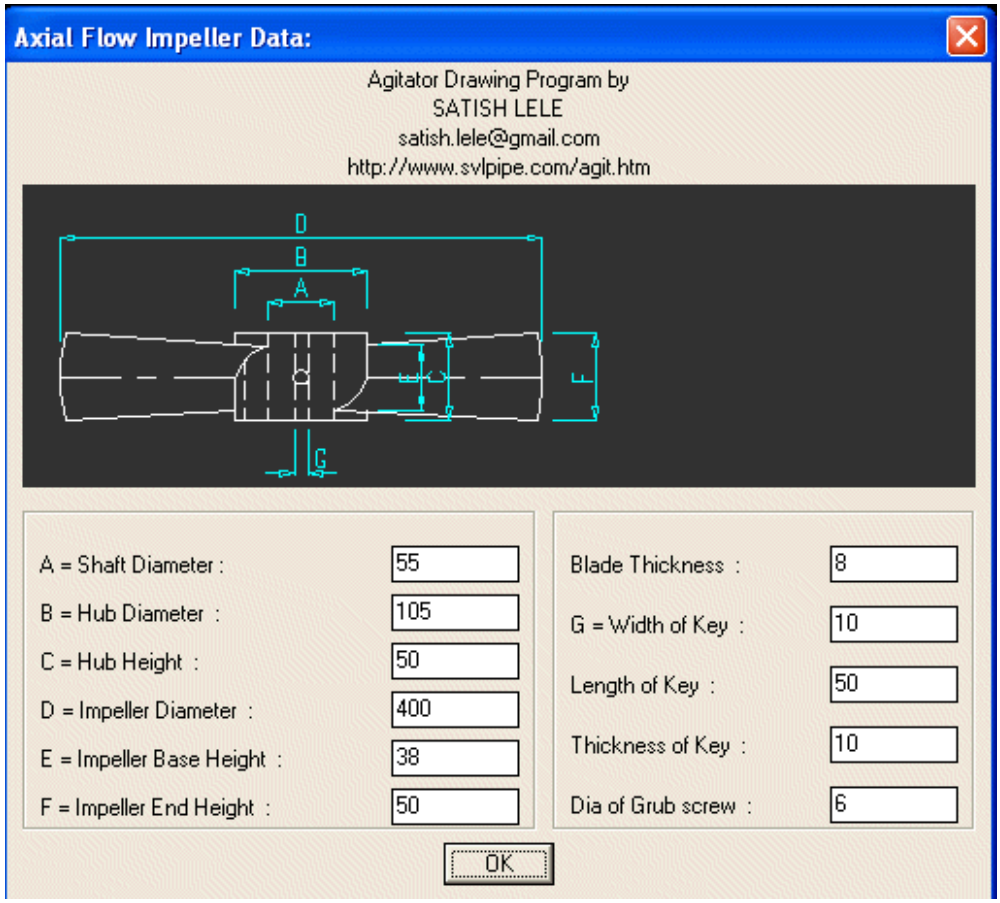
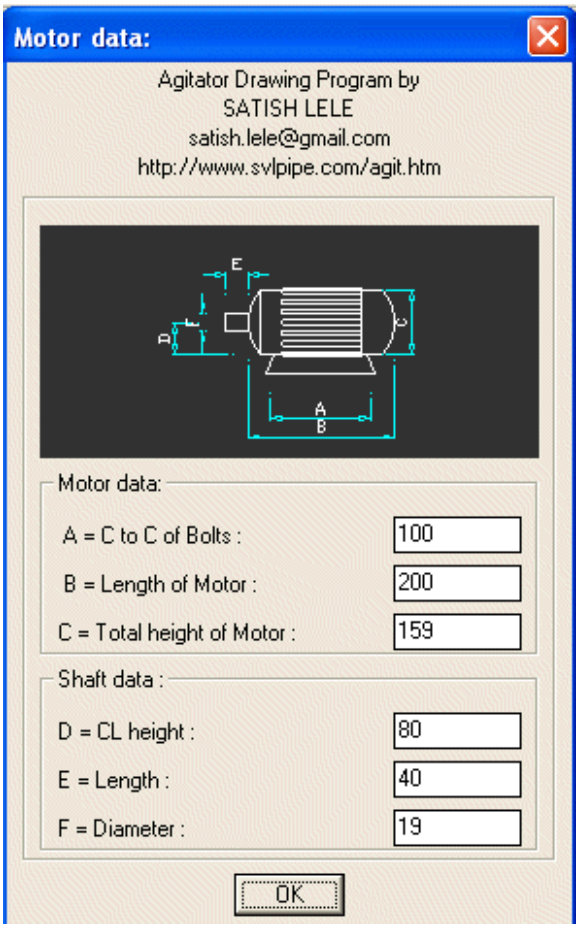
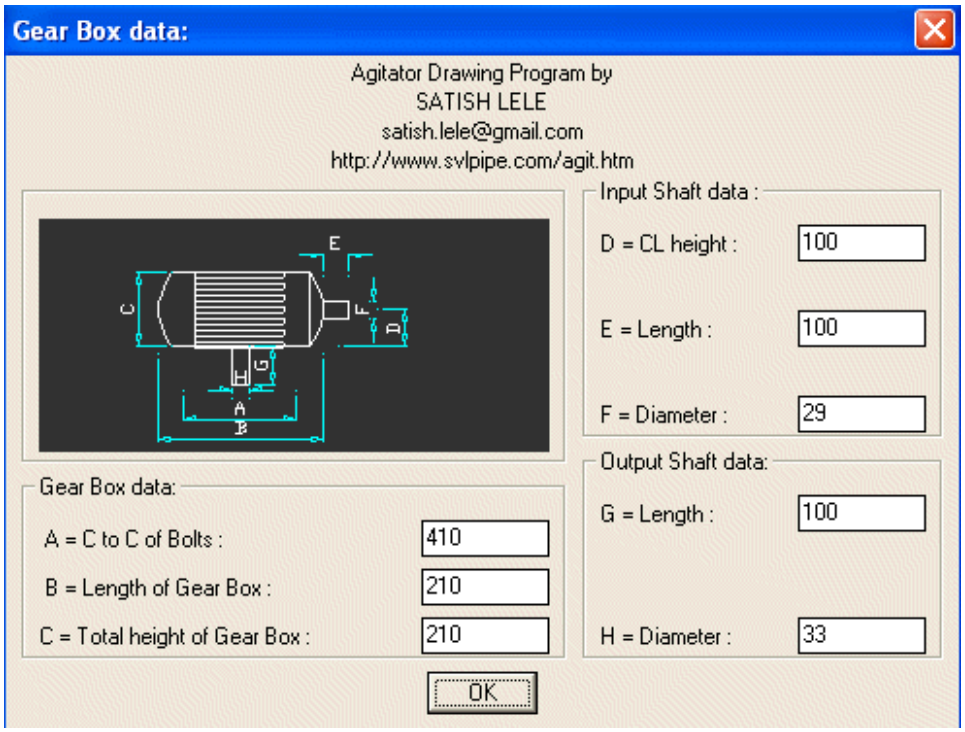



Program automatically calculates all the demensions and shows in this table. You can accept the same or change sizes for parts of Impeller.




You can select sizes for parts of Motor. The default values are based on standard motors.



You can select sizes for parts of Gear Box. The default values are based on standard gearboxes.


You can select to redesign, draw or exit. If you select drawing option its starts Dialog Boxes for drawing.

## Design of Agitators / Mixers for Vessels with Drawing

For Agitators / Mixers, factors to be considered for design are

1. Type of Agitation: Agitation can be Vigourous, Moderate or Mild. For Vigourous mixing, time required for total mixing can be few seconds. For Moderate mixing, time required for total mixing can be few minutes. For Mild mixing, time required for total mixing can be few hours. Degree of agitation increases with increase in number of revolutions of agitator and increase in impeller diameter.

2. Type of Agitator: Generally it is mounted vertically at the top of the tank. This is the normal practice for mounting an agitator in small and medium size tanks. It is also mounted horizontally from side of a tank, called side entering agitator, for very large diameter storage tanks.

3. Pattern of Circulation: Axial or Radial. When a vessel is heated or cooled by coil or jacket, axial flow is prefered. When the contents are to be mixed, radial circulation is prefered. When both patterns of circulation are required, radual flow impeller is installed at the bottom of agitator shaft, while radial flow impeller is installed at the center of agitator shaft.

4. Location of agitator in the equipment: Generally it is centrally located for better flow pattern. It is located off-center if some part of vessel is occupied by internal coil or some other internal.

5. Shape and size of tank: Vertical cylindrical vessel is the best type for installing an agitator. However, it is also installed in vertical rectangular tank, in water and waste water treatment tanks.

6. Impellers: There can be following simple Impellers. Marine Propeller, Axial Flow Turbine, Turbo Propeller, Disc Blade turbine, Flat Blade Turbine, Backward turned turbine, Paddle, Anchor, Anchor/Paddle or Gate. Main parts of impeller are hub and blades. Hub is installed on the shaft by shaft key and grub screw. Impellers may be one piece or split into two or many pieces, bolted together. Marine Propeller is generally a casting. All other impellers are of fabricated construction and can be either Bolted or Welded type.

7. Diameter of Agitator: It depends on diameter of tank. It is generally 1/3rd the diameter of the tank for

    - Marine Propeller
    - Axial flow turbine
    - Turbo Propeller
    - Disc Blade turbine
    - Flat Blade turbine
    - Backward Blade turbine

    It is generally 80% of the diameter of the tank for
    - Paddle
    - Anchor
    - Anchor/Paddle
    - Gate

8. Baffles / Coils: Generally 4 baffles are provided in a vertical cylindical vessel for good mixing in case of first 6 (axial flow) impellers. For last 4 (radial flow), no baffles are provided. Coils are provided in some vessels, for heating or cooling. Baffles and coil reduce effective diameter of the vessel.

9. Power required for agitation: It depends on diameter of impeller, revolutions of agitator shaft, power number of impeller, number of impellers, density, content of solids and viscocity of liquid.

10. Overhang of shaft and lower fixed bearing: The shaft is supported at the top end by bearing housing assembly. The lateral movement of impeller at the bottom of the shaft, tries to bend the shaft, if shaft is long (more than 3 meters). To avoid this a bottom bearing is provided. It is a non rotating bearing, made of a sleeve of softer metal or plastic material.

11. Type of Seal: Stuffing Box or Mechanical Seal: A seaing arrangement is provided in a closed vessel, along agitator shaft at the top. This does not allow vapours to leak out of vessel, along the rotating shaft. These can be of two types.

    - Stuffing Box: This has two shells. The diameter of inner shell is larger than diameter of shaft. 3 or 4 packing rings are installed in this gap at bottom, followed by latern ring on top and 3 or 4 packing rings on top. Packing rings act as sealant while latern ring provides lubrication to shaft. The top rings are pressed from top by a ring. Cooling water flows in outer shell, which keeps the packing rings and lantern ring cool. It fits diectly on top of closed vessel inside the stool.

    - Mechanical Seal: It is similar to stuffing box, but in this mechanical seals are provided in place of packing rings. Mechanical seal assembly is readily avaible as one unit. It can have one mechanical seal (Single mechanical seal unit) or two mechanical seals (Double mechanical seal unit). In Double mechanical seal unit, one mechanical seal is at top and one at bottom. These provide better sealing along the agitator shaft. These are used in case of vessels having high vacuum inside or if vapours are corrosive. These are expensive and difficult to mentain.

12. Number of Bearings on Shaft: There can be bearing housings with 2 or 1 bearings. For agitators having short length, there can be no bearing housing.

- Double Bearing Housing: A housing in which 2 ball bearings are installed, called double bearing housing, is prefered as it reduces deflection of shaft. This normally used for shafts rotating at higher speeds, with Marine Propeller, Axial flow turbine, Turbo Propeller, Disc Blade turbine, Flat Blade turbine, Backward Blade turbine Impellers. One bearing is installed at the top and one at bottom. Arrangement for greasing the bearings is provided for both bearings.

- Single Bearing Housing: A housing in which 2 ball bearings are installed, called double bearing housing, is prefered as it reduces deflection of shaft. This normally used for shafts rotating at slow speeds, with Paddle, Anchor, Anchor/Paddle, Gate impellers.

- No Bearing Housing

13. Drive Assembly: A number of combinations are possible, based on speed of drive motor and rotational speed of shaft of agitator.

    - Vertically mounted motor: It is mounted on top of stool. It is used when rotational speed of shaft of agitator is same as that of motor.

    - Vertically mounted geared motor: It is mounted on top of stool. It is used when rotational speed of shaft of agitator is same as that of reducing gear integral with motor.

    - Vertically mounted motor with pulleys and V belts: It is mounted on the side of stool. It is used when rotational speed of shaft of agitator is not the same as that of motor. A combination of pulleys of different diameters, with V belts, reduces the rotational speed of shaft of agitator to required speed.

    - Directly coupled horizontal gearbox and motor: It is mounted on the top of stool. Gearbox is mounted directly on top of stool and motor is placed on side platform. It is used when rotational speed of shaft of agitator is same as output speed of gearbox.

    - Horizontal gearbox and motor coupled by pulleys and V belts: It is mounted on the top of stool. Gearbox is mounted directly on top of

stool and motor is placed on side platform. Pulleys and V belts are used to get exact input speed of gearbox. It then matches rotational speed of shaft of agitator with the output speed of gearbox.

14. Mixing by agitators: It takes place by momentum transfer. Marine Propeller, Axial Flow Turbine, Turbo Propeller, Flat Blade Turbines, have smaller blade area and these rotate at relatively high speeds (100 to 400 RPM). These are used to mix liquids with low viscosity. Agitators having large blade area like Paddle, Anchor, Anchor/Paddle or Gate rotate at lower speeds (40 to 50 RPM). These are used to mix liquids with high viscosity. Top entering agitators are used for smaller size vessels (1,000 to 10,000 liters) and for applications involving higher power requirements per unit volume. Side entering are installed in storage tanks having large diameters (more than 10 meters), with non-corrosive liquids, especially in tanks which store Crude Petroleum.

    Type of Agitators and their functions

    - Marine Propeller is generally an item produced by casting process in a foundry and it has 3 or 4 blades. Cast agitators have two basic advantages, uniformity of material and hard surface. These have tapering blades, and angle of blade varies from root to tip. This produces maximum axial flow. The diameter of Marine Propeller impeller is 15% to 30% of diameter of tank. These have tip speeds between 300 to 500 meters per minute.

    - Axial Flow Turbine, Turbo Propeller and Flat Blade Turbine have blades ranging from 3 to 6. These have tip speeds between 200 to 300 meters per minute. The diameter of impeller is 25% to 60% of tank diameter. For Axial Flow Turbine and Turbo Propeller, the angle of blade varies from 30 degrees (for less viscous liquids) to 60 degrees (for more viscous liquids). Standard angle is 45 degrees. Power requirement increases with higher pitch angle. For Flat Blade Turbine, the length of blade is 25% of diameter, and disk diameter is 60% to 70% of the diameter of impeller.

- Paddle, Anchor, Anchor/Paddle or Gate have only 2 blades. These extend close to the tank wall and have tip speeds between 80 to 150 meters per minute. These push and rotate the liquid in a laminar flow. There is no axial or radial mixing. The width of blade is 1/8th or 1/10th of the agitator diameter.

- There are more complex impeller like helical screws, cones and high speed discs.

15. There can be one or more impellers on shaft. Number of agitators = (Maximum liquid height x average specific gravity) / Diameter of tank. The gap between two impellers = Liquid height / (Number of impellers - 0.5).

16. Most important parameters are diameter and length of agitator shaft and impeller diameter. These are decided by process design calculations.

17. Gland seal can be either Stuffing Box or Mechanical seal. If you select Mechanical Seal, it can be Single or Double Mechanical Seal.

18. Couplings used for connecting agitator shaft to drive shaft is rigid coupling.

19. Bearing housing is used to hold bearings in it. Bearings outside the tank give rigidity against bending of the shaft. There can be double bearings for long shaft, single bearing for shorter shafts. No bearing is generally provided for agitators installed on open tanks. Internal bearings help in holding shaft in position. A bottom bearing is provided for a long shaft.

20. Material of construction for wetted parts can be Stainless Steel, Carbon Steel or other metals and alloys. SS liner is provided on CS base plate if wetted parts are SS.

21. Top and bottom stool is provided for housing Gland and Bearing Housing. Base Plate is provided to install assembly on it.

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To do process design of agitator, first the volume of vessel is calculated.
For Vertical Cylindrical Vessels.
Vessel Volume = (pi * vessel dia * vessel dia * vessel len) / 4.0
Agitator Shaft length = vessel length + (vessel dia * 0.25).

For Rectangular Tanks.
Tank Volume = Vessel Length * Vessel Breadth * Vessel Height.
Agitator Shaft length = Vessel Height.
You have to then find out Viscocity and Specific Gravity of Liquid that will be in the vessel.

Based on Viscocity and Specific Gravity of Liquid, design will depend on Reynold's Number.

- If the liquid is very viscous (viscocity = 500 to 1000 cp) the Reynold's Number can be in laminar zone. For this range, Reynold's Number is less than 200.
- If the liquid is less viscous (viscocity = 100 to 500 cp) the Reynold's Number can be in laminar zone. For this range, Reynold's Number is 200 to 10,000.
- If the liquid is not viscous (viscocity = 1 to 100 cp) the Reynold's Number can be in turbulent zone. For this range, Reynold's Number is greater than 10,000.

Based on geometry of vessel, many factors for impeller can be decided.

1. Marine Propeller:
    - Agitator speed, RPM of shaft is prefered as 100 or 200 or 300. This speed is easier to achieve with motor/gearbox combination.
    - Power number, which decides power required for mixing, is 0.3 for 3 bladed and 0.33 for 4 bladed impeller.
    - Pumping factor, which decides flow rate of mixing, is 0.33 for 3 bladed and 0.34 for 4 bladed impeller.

- Pumping factor, which decides flow rate of mixing, is 0.33 for 3 bladed and 0.34 for 4 bladed impeller.

2. Axial flow turbine:

- Agitator speed, RPM of shaft is prefered as 100 or 200 or 300. This speed is easier to achieve with motor/gearbox combination.

- Power number, which decides power required for mixing, is 1.35 for 3 bladed, 1.4 for 4 bladed, 1.45 for 5 bladed, 1.5 for 6 bladed impeller.

- Pumping factor, which decides flow rate of mixing, is 0.6 for 3 bladed 0.69 for 4 bladed, 0.78 for 5 bladed, 0.87 for 6 bladed impeller.

- Diameter of impeller is generally 1/3rd the diameter of the tank.

3. Turbo Propeller:

- Agitator speed, RPM of shaft is prefered as 100 or 200 or 300. This speed is easier to achieve with motor/gearbox combination.

- Power number, which decides power required for mixing, is 1.35 for 3 bladed, 1.4 for 4 bladed, 1.45 for 5 bladed, 1.5 for 6 bladed impeller.

- Pumping factor, which decides flow rate of mixing, is 0.6 for 3 bladed 0.69 for 4 bladed, 0.78 for 5 bladed, 0.87 for 6 bladed impeller.

- Diameter of impeller is generally 1/3rd the diameter of the tank.

4. Disc Blade turbine:

- Agitator speed, RPM of shaft is prefered as 100 or 200 or 300. This speed is easier to achieve with motor/gearbox combination.

- Power number, which decides power required for mixing, is 5.0.
- Pumping factor, which decides flow rate of mixing, is 0.7 to 0.8.
- Diameter of impeller is generally 1/3rd the diameter of the tank.

5. Flat Blade turbine:

- Agitator speed, RPM of shaft is prefered as 100 or 200 or 300. This speed is easier to achieve with motor/gearbox combination.
- Power number, which decides power required for mixing, is 5.0.
- Pumping factor, which decides flow rate of mixing, is 0.7 to 0.85.
- Diameter of impeller is generally 1/3rd the diameter of the tank.

6. Backward Blade turbine:

- Agitator speed, RPM of shaft is prefered as 100 or 200 or 300. This speed is easier to achieve with motor/gearbox combination.
- Power number, which decides power required for mixing, is 5.0.
- Pumping factor, which decides flow rate of mixing, is 0.65 to 0.85.
- Diameter of impeller is generally 1/3rd the diameter of the tank.

7. Paddle:

- Agitator speed, RPM of shaft is prefered as 50. This speed is easier to achieve with motor/gearbox combination.
- Power number, which decides power required for mixing, is 5.0.
- Pumping factor, which decides flow rate of mixing, is 0.03.
- Diameter of impeller is generally 80% the diameter of the tank

8. Anchor:
    - Agitator speed, RPM of shaft is prefered as 50. This speed is easier to achieve with motor/gearbox combination.
    - Power number, which decides power required for mixing, is 5.0.
    - Pumping factor, which decides flow rate of mixing, is 0.05.
    - Diameter of impeller is generally 80% the diameter of the tank
9. Anchor/Paddle:
    - Agitator speed, RPM of shaft is prefered as 50. This speed is easier to achieve with motor/gearbox combination.
    - Power number, which decides power required for mixing, is 5.0.
    - Pumping factor, which decides flow rate of mixing, is 0.07.
    - Diameter of impeller is generally 80% the diameter of the tank
10. Gate:
    - Agitator speed, RPM of shaft is prefered as 50. This speed is easier to achieve with motor/gearbox combination.
    - Power number, which decides power required for mixing, is 5.0.
    - Pumping factor, which decides flow rate of mixing, is 1.0.
    - Diameter of impeller is generally 80% the diameter of the tank

**Calculation of Diameter of Impeller**

1. For Marine Propeller, Axial flow turbine, and Turbo Propeller, based on the Type of Impeller, Agitator speed and Reynold's number selected, program will calculate the diameter of the impeller. Program reitirates till the width factor of impeller diameter to vessel diameter, is achieved by increasing or decreasing the agitator speed. It will indicate the calculated

agitator speed and diameter of impeller. You can round it up to nearest value.

- Output Speeds of 1500 rpm Motor with Gearbox are : 300, 200, 150, 120, 100, 75, 60, 50, 43, 37 30, 25, 22.
- Output Speeds of 1000 rpm Motor with Gearbox are : 200, 133, 100, 80, 67, 50, 40, 33, 29, 25, 20, 17, 14.
- Output Speeds of 750 rpm Motor with Gearbox are : 150, 100, 75, 60, 50, 38, 30, 25, 21, 19, 15, 13, 11.
- Output Speeds of Direct coupled Motor are : 1500, 1000, 750.
- For any other speeds use Motor + V Belt Drive.

It then calculates pumping rate. Pumping rate = (pumpfac * (shaft rpm / 60.0) * impeller od$^3$) in cu mm / sec. It then calculates Mixing time = Vessel Volume / Pumping Rate. Program indicates the value of mixing time. You can choose mixing time as per your requirements.
Program will recalculate the diameter of the impeller and shaft rpm. You can choose these per your requirements.
Program asks for number of impellers on shaft. If these are more than one, program will recalculate the diameter of the impeller. You can choose it per your requirements.

2. For Disc Blade turbine, Flat Blade turbine and Backward Blade turbine: Diameter of impeller depends on Width factor to Vessel Diameter. Program calculates Impeller OD and indictes it.
   Tip speed of impeller = 175 meters per minute, or 500 feet per minute. Agitator Speed depends on tip speed of impeller. It calculates RPM of agitator.

3. For Paddle, Anchor, Anchor/Paddle and Gate: Diameter of impeller depends on Width factor to Vessel Diameter. It calculates Impeller OD. Tip speed of impeller = 82.5 meters per minute or 250 feet per minute. Agitator Speed depends on tip speed of impeller. It calculates RPM of agitator.

Program then calculates the power absorbed for mixing.
Absorbed Power in HP = (specific gravity * 1000 * number of impellers * power number * (shaft rpm / 60.0)$^3$ (impod / 1000.0)$^5$ * 1.1 * 1.2) / (9.81 * 75.0)
If the shaft RPM is less than 300, based on the absorbed power (output power of gearbox) and output RPM of gearbox, it selects gearbox. It indicates selected size of gearbox, which can be changed to next higher or lower value.
It then calculates diameter of shaft. You can select 4 types of materials for shaft. Indicated values of Yield Stress and Elastic Limit, in Kgs/ mm$^2$ are as follows.
Carbon Steel: Shear Stress 30.0, Elastic Limit 170.0.
EN8: Shear Stress 55.0 Elastic Limit 246.0
EN24: Shear Stress 80.0 Elastic Limit 320.0
Stainless Steel: Shear Stress 50.0 Elastic Limit 230.0
You can select Safety Factor for calculation of shaft diameter. Torque at end of shaft = (746 * motor hp) / (2 * pi * (rpm / 60)) [in N-mt]
Bending Moment = Torque * Safety Factor [in N-mm]
Force at the end of impeller blade, Fm = Bending Moment / (0.75 * 0.5 * Impeller Dia)
It then calculates maximum Bending Moment is at the end of shaft, Average Bending Moment at the end of shaft and Polar modulus of the shaft in cubic mm.
It then recalcuates Diameter of Impeller based on Critical Speed. and indicates recommended Impeller OD for Critical Speed. It then reiterates till elastic limits is less than permisiible value by increasing shaft diameter. It then calculates Critical Speed of Impeller. It then reiterates till critical speed is more than 20% of agitator speed by increasing shaft diameter.
It then indicates Final values after calculation of Critical Speed, Shaft RPM, Impeller Diameter and Shaft Diameter.