Estimation of surface areas

Helping preparing coating projects and paint volume predictions

Introduction

Calculating the volume of paint needed, starts with understanding the size of the area to be coated. For simple geometrical shapes, well known formulas are available. The practical requirements may then be increased by deviations in exact shape such as a dome roof vs. flat roof and roof support structures in land storage tanks for instance.

Several example formulas are given here and a calculation tools is available on the Transocean-Coatings.com website for download.

Note that these calculations give an area, not a paint volume and that loss factors should be taken into consideration. See our separate paint coverage calculations document and the “Guidance to Transocean Coatings product datasheets for more information.

Geometrical shapes

With geometrical shapes we mean those that can be described with relatively straight forward dimensions. In such cases formulas describing the area to be coated can be kept simple.

For a basic cylinder shape, the formula for the area can be used to calculate the area of a land storage tank or a pipe (note: we use x to depict multiplication):

Tank

Flat roof or bottom: $\pi \times r^2$ (or $0.25 \times D^2$), $\pi \approx 3.14$ *

Wall: $2 \times \pi \times r \times H$ (or $\pi \times D \times H$)

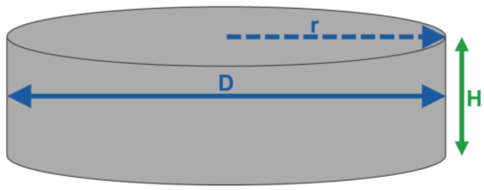

Figure 1: basic flat roof tank shape

Pipe

Wall: $2 \times \pi \times L$ (or $\pi \times D \times L$)

Generally the differences between inner and outer diameter make an insignificant difference but in case of high wall thickness, this should be taken into consideration.

Figure 2: pipe

Dome tank roof dimensions

For spherical dome shapes, the area can be calculated if the roof height (h_r in the drawing) is known. The floor and wall remain as above.

Area of the roof: $2 \times \pi \times h_r \times (r^2 + h_r^2)/(2 \times h_r)$

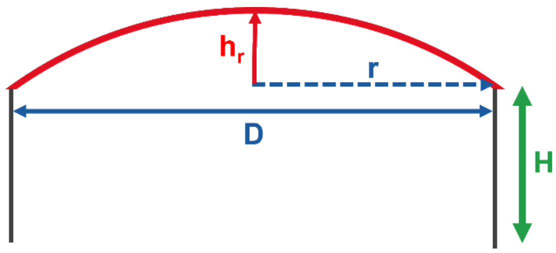

Figure 3: dome tank shape

* or use PI() in Excel

Introduction on hull paint estimations

For a flat plate or simple three dimensional shapes this is relatively straight forward, as can be seen in the above. Calculating a ships underwater hull area, or wetted area, is a lot more complex and only estimations can be made without exact drawings and computational tools.

To understand the amount of paint needed for different vessels areas, an estimation formula as explained in the next paragraph can be used as a rough guidance tool or

- Information on paint consumption from previous dockings
- Calculations based on the original design drawings using a CAD system

Complicating factors in all cases are how to include bilge keel, stabilizers, rudder and other niche areas that may or may not require coating with the same system.

Hull shape

If a ship's hull has a box shape, the immersed or wetted surface area of the (partially) immersed box is easily calculated if we consider the red parts as immersed (below the water line):

Partially immersed box shape:

If we consider the red part of the box in Figure 4 to be immersed, the wetted areas can be calculated as follows:

Sides: $2 \times L \times T$ (Length x Draft)

Front and back: $2 \times B \times T$ (Breadth x Draft)

Bottom: $L \times T$

Area: $2 \times (L \times D) + 2 \times (B \times T) + (L \times T)$

Note: T is used for draft to prevent misunderstanding with D for depth (hull height) in later formulas.

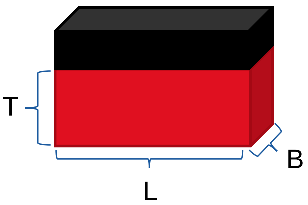

Figure 4: partially immersed box

An actual ship's hull will have a lower wetted area. How much lower depends on the shape of the hull, based on experience some shape factors are being suggested to estimate the wetted area of certain vessels types.

To help understand this, consider the following side views. The sharper bow angle and shorter overall verticals of the second shape, at the same draft, mean a smaller area needs to be coated vs. the corresponding box shape (outlined). The correction factor for these sides (simplified, assuming they are purely vertical and flat) would be ≈0.9 for the first hull and ≈0.8 for the second one. I.e. they would require about 90% or 80% of the paint compared the requirement for rectangles of the same length and height.

Figure 5: long hull, short bow shape, correction factor ±90% vs. rectangular shape

Figure 6: shorter hull, longer bow shape, correction factor ±80% vs. rectangular shape

The hull shape as seen from the front has an effect on the overall wetted area. As the shapes of the blocks varies from bow to stern, it is nearly impossible to manually calculate the effect on the wetted area. In ship design "block factors" are used to calculate the displacement of a hull shape. A similar thing could be done for the sectional length of the metal to be coated from the port to the starboard waterline (red lines in below).

Figure 7: sectional shapes; box (set as 100%), shaped hull (±88% vs box), triangle (±71% vs. box)

Based on the industry experience, empirical models area available in literature. The resulting formulas for wetted area differ in level of detail of the required input and the hull designs covered. The simplest model, that requires readily available information, is given below. It can be seen as a combination of the side view and sectional factors explain in above.

A similar approach with correction factors can be taken for the deck, note this includes the area taken up by superstructures, deck fittings and for instance hatch covers.

Hull area estimation required dimensions

Figure 8: vessel dimensions side view

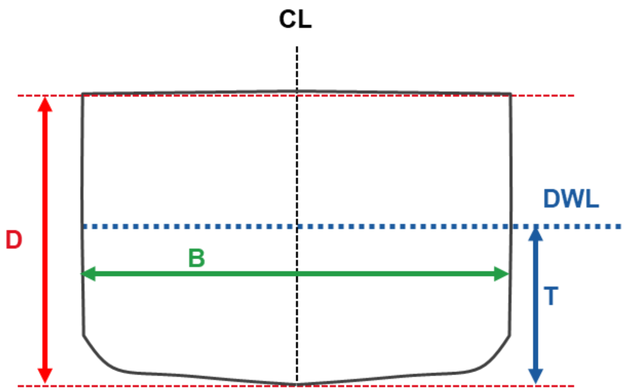

Figure 9: vessel dimension sectional view

Dimensions

B = Breadth extreme

D = Depth / Hull Height

T = Draft

Lpp = Length between perpendiculars

Loa = Length over all

Abbreviations

DWL = Design Water Line

CL = Centre Line

Hull area estimation formulas and factors

Under water area (bottom incl. boot top)

Area = $((2 \times T) + B \times Lpp \times C_H$

C_H = hull shape factor

≈ 0.90 for large tankers

≈ 0.85 for bulk carriers

≈ 0.70 – 0.75 for smaller dry/general cargo vessels

Topsides

Area = $2 \times H \times (Loa + 0.5 \times B)$

H = heigh t of topsides (D - T)

Weather decks

(including top of superstructures and hatch covers)

Area = $Loa \times B \times N$

C_D = deck shape factor

≈ 0.91 for large tankers and bulk carriers

≈ 0.88 for general cargo vessels

≈ 0.84 for coasters etc.

Disclaimer

The calculations and information described in this document should be used as supporting guidance and for estimation purposes only. There are many factors that affect the practical consumption of paint that are project and location specific, it is necessary to build in one's own safety margins when estimating required paint volumes.

The information described in above is based on data, which to the best of our knowledge, is reliable. This information is intended for users having the relevant knowledge and industrial experience, it is the user's responsibility to determine the suitability for their specific case at their own discretion and risk.