# COURSE NAME: INDUSTRIAL PIPING SYSTEM

# LECTURE VI-WEEK VI: STANDARD PIPE SIZES

# COMMON USED IN PIPING SYSTEM


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# OBJECTIVES

By the end of this session the learner/student will be able to:

- ✓ Identify pipe size standard parameters
- ✓Describe the Nominal pipe size
- ✓Describe the pipe schedule number
- ✓Differentiate pipe’s outer, inner and nominal diameter.

# VI.1. Introduction

Generally, pipe size is specified by two designations: a nominal pipe size (NPS) for diameter based on inches, and a schedule for all thickness.

The European (ISO) designation equivalent to NPS is DN (Nominal Diameter), in which sizes are measured in millimetres. The term NB (nominal bore) is also frequently used interchangeably with NPS

# VI.2. Pipe size

In current practice, pipe size defines with two sets of number:

1) Pipe bore which also known as nominal diameter and
2) Pipe schedule which is nothing but wall thickness of pipe.

There are other important terms Nominal Pipe Size (NPS), NB and DN which are also used to mention pipe diameter.

# a. Nominal Pipe Size(NPS)

- ✓Nominal Pipe size is the number that define the size of the pipe.
- ✓For example, when you say 6 inches pipe, the 6 inches is the normal size of pipe.
- ✓From 1/8 inch up to 12 inches pipe, Nominal Pipe size is neither Outer Diameter or Internal Diameter of the pipe.
- ✓Example of a 4 inches schedule 80 pipe size and thickness. For this example, the outer diameter is 4.5 inches and the thickness is 0.337 inch.

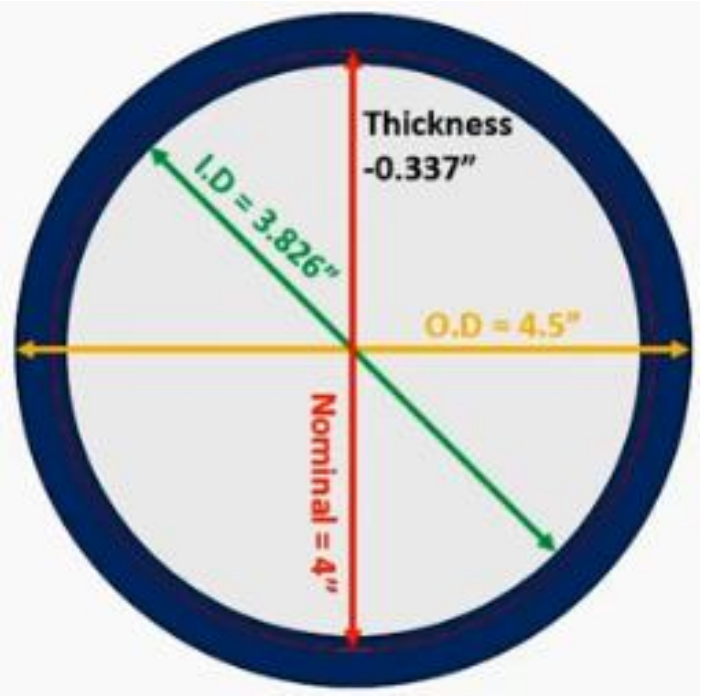


*Fig.1: OD, ID & Thickness illustration*

***Source:*** *(HardHat Engineer, 2019)*

# Nominal Pipe Size(NPS Cont'd

So, it is mentioned that OD is 4.5 inches, internal diameter is 3.826 inches and thickness is 0.337 inch. Thus, the nominal diameter is 4 inches which is the average diameter between OD and ID. This shows that it is located somewhere in between OD and ID.

However, for the pipe sizes where NPS equals to 14 inches and above, the outside diameter is the same as the nominal pipe size.

# b. Nominal Bore (NB)

NPS=NB is an American way to refer pipe dimensions. NPS is frequently referred as a NB or Nominal Bore. As such there is no difference between NB and NPS; they are the same.

People also use NB and DN interchangeably. DN or Diameter Nominal is international designator. It is an SI or Metric Designator which is an European equivalent of NPS to show pipe size.

Here, we have to be aware that DN shows pipe sizes differently FROM NPS where a 2 inches NPS is DN 50 and 8 inches NPS as DN 200.

Simply, NPS is converted to DN by multiplying NPS by 25.

## c. Other examples of NPS to DN conversion:

| size | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NPS (Inch) | 1/2 | 3/4 | 1 | 1 1/2 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
| NB/DN (mm) | 15 | 20 | 25 | 40 | 50 | 80 | 100 | 150 | 200 | 250 | 300 |

***Source:*** *(HardHat Engineer, 2019)*

From the table above, it is clear that NPS is converted to DN by multiplying NPS by 25. check the table carefully for easy understanding. There is no change in other dimensions such as thickness and OD when you use DN.

# d. Pipe schedule number

Pipe schedule number is the way pipe wall thickness is mentioned. Schedule number is based on modified Barlow's wall thickness formula.

Schedule number = 1000*P/S; where P is the service pressure in (psi)

S is the allowable stress in (psi).

**Example:**

What does schedule 40 means?

Schedule 40 is nothing but a pipe thickness designator. Briefly, you can say that for a given material, schedule 40 pipe can withstand certain amount of pressure.

In order to keep consistency with the pipe fitting sections, it was nowadays decided to relate the outer diameter with the “nominal pipe size” classification, so when we’re dealing with a one-inch pipe we can consult data tables and figure out its specific “outer diameter”. Next, there is the “wall thickness” of the pipe that is used by engineers to determine whether a pipe section is suitable to handle the designated pressures or not, categorized in “schedules”.

The pipe's wall thickness practically determines the strength of the pipe but it also helps us derive the **"inner diameter"** of the pipe. Based on the aforementioned consideration, we can simply calculate the inner diameter of a pipe by subtracting the pipe wall thickness twice from the number that corresponds to the outer diameter. This consideration is important for engineers since the inner diameter is what determines the flow velocity and rate. For example, a pipe that has an outer diameter of 60.3 mm and a wall thickness of 2.8, has an internal diameter of 60.3 – (2.8 x 2) = 54.7 mm.

# VI.3. The difference between pipe schedule(SHC) and pipe diameters

Pipe schedule is how the wall thickness of a pipe is described. It is not the actual measurement, but a guide number based on a wall thickness formula. Two pipes of the same diameter may have different schedules which means that they have a different wall thickness. For specifying a pipe for high pressure application will select a bigger number which represents a bigger schedule (wall thickness).

# The difference between pipe schedule(SHC) and pipe diameters Cont'd

Additionally, in the case of stainless steel, piping schedules are specified with a letter 's' as a suffix after the number. An example to illustrate is an NPS 14 pipe with a schedule of 40s. The reason stainless steel's schedules are treated in this way is due to their extra strength. Less wall thickness is required to withstand the same pressure as compared with other steels.

# VI.4. Comparison between steel, stainless steel and PVC Pipes parameters-Schedule 40&80

Taking a look at pipe parameters shown in the tables below on different types of materials; steel, stainless steel and PVC Pipe for schedule 40 and 80 we can see how these parameters change. These parameters were also compared for NPS ranging between 1/8 Inch to 24 Inch. For schedule 40, pipe with 1/8 to 1 inch for all materials mentioned in table they have the same parameters. This shows that except weight these pipes have same dimensions.

# Comparison between steel, stainless steel and PVC Pipes parameters-Schedule 40&80 Cont'd

For the pipes of schedule 80, other parameters except weight they are the same for pipes having NPS ranging from1/8 to 8 Inch. This shows that under the same conditions, different materials may have the same parameters as we see that for steel, stainless steel and PVC Pipes ranging from 1/8 to 8 Inch NPS have the same dimensions.

# a. Steel Pipe Sizes - Schedule 40

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 1/8 | 0.405" | 0.269" | 0.068" | 0.24 lb/ft |
| 1/4 | 0.540" | 0.364" | 0.088" | 0.42 lb/ft |
| 3/8 | 0.675" | 0.493" | 0.091" | 0.57 lb/ft |
| 1/2 | 0.840" | 0.622" | 0.109" | 0.85 lb/ft |
| 3/4 | 1.050" | 0.824" | 0.113" | 1.13 lb/ft |
| 1 | 1.315" | 1.049" | 0.133" | 1.68 lb/ft |
| 1-1/4 | 1.660" | 1.380" | 0.140" | 2.27 lb/ft |
| 1-1/2 | 1.900" | 1.610" | 0.145" | 2.72 lb/ft |
| 2 | 2.375" | 2.067" | 0.154" | 3.65 lb/ft |
| 2-1/2 | 2.875" | 2.469" | 0.203" | 5.79 lb/ft |
| 3 | 3.500" | 3.068" | 0.216" | 7.58 lb/ft |
| 3-1/2 | 4.000" | 3.548" | 0.226" | 9.11 lb/ft |
| 4 | 4.500" | 4.026" | 0.237" | 10.79 lb/ft |
| 5 | 5.563" | 5.047" | 0.258" | 14.62 lb/ft |

# Steel Pipe Sizes - Schedule 40 Cont'd

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 6 | 6.625" | 6.065" | 0.280" | 18.97 lb/ft |
| 8 | 8.625" | 7.981" | 0.322" | 28.55 lb/ft |
| 10 | 10.750" | 10.020" | 0.365" | 40.48 lb/ft |
| 12 | 12.75" | 11.938" | 0.406" | 53.52 lb/ft |
| 14 | 14.000" | 13.124" | 0.438" | 63.50 lb/ft |
| 16 | 16.000" | 15.000" | 0.500" | 82.77 lb/ft |
| 18 | 18.000" | 16.876" | 0.562" | 104.70 lb/ft |
| 20 | 20.000" | 18.812" | 0.594" | 123.10 lb/ft |
| 24 | 24.000" | 22.624" | 0.688" | 171.30 lb/ft |

# b. Steel Pipe Sizes - Schedule 80

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 1/8 | 0.405" | 0.215" | 0.095" | 0.32 lb/ft |
| 1/4 | 0.540" | 0.302" | 0.119" | 0.54 lb/ft |
| 3/8 | 0.675" | 0.423" | 0.126" | 0.74 lb/ft |
| 1/2 | 0.840" | 0.546" | 0.147" | 1.09 lb/ft |
| 3/4 | 1.050" | 0.742" | 0.154" | 1.47 lb/ft |
| 1 | 1.315" | 0.957" | 0.179" | 2.17 lb/ft |
| 1-1/4 | 1.660" | 1.278" | 0.191" | 3.00 lb/ft |
| 1-1/2 | 1.900" | 1.500" | 0.200" | 3.63 lb/ft |
| 2 | 2.375" | 1.939" | 0.218" | 5.02 lb/ft |
| 2-1/2 | 2.875" | 2.323" | 0.276" | 7.66 lb/ft |
| 3 | 3.500" | 2.900" | 0.300" | 10.25 lb/ft |
| 3-1/2 | 4.000" | 3.364" | 0.318" | 12.50 lb/ft |
| 4 | 4.500" | 3.826" | 0.337" | 14.98 lb/ft |
| 5 | 5.563" | 4.813" | 0.375" | 20.78 lb/ft |

# Steel Pipe Sizes - Schedule 80 Cont’d

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 6 | 6.625" | 5.761" | 0.432" | 28.57 lb/ft |
| 8 | 8.625" | 7.625" | 0.500" | 43.39 lb/ft |
| 10 | 10.750" | 9.562" | 0.594" | 64.42 lb/ft |
| 12 | 12.75" | 11.374" | 0.688" | 88.63 lb/ft |
| 14 | 14.000" | 12.500" | 0.750" | 106.10 lb/ft |
| 16 | 16.000" | 14.312" | 0.844" | 136.58 lb/ft |
| 18 | 18.000" | 16.124" | 0.938" | 170.87 lb/ft |
| 20 | 20.000" | 17.938" | 1.031" | 208.92 lb/ft |
| 24 | 24.000" | 21.562" | 1.219" | 296.58 lb/ft |

# c. Stainless Steel Pipe Sizes - Schedule 40S

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 1/8 | 0.405" | 0.269" | 0.068" | 0.25 lb/ft |
| 1/4 | 0.540" | 0.364" | 0.088" | 0.40 lb/ft |
| 3/8 | 0.675" | 0.493" | 0.091" | 0.58 lb/ft |
| 1/2 | 0.840" | 0.622" | 0.109" | 0.87 lb/ft |
| 3/4 | 1.050" | 0.824" | 0.113" | 1.20 lb/ft |
| 1 | 1.315" | 1.049" | 0.133" | 1.68 lb/ft |
| 1-1/4 | 1.660" | 1.380" | 0.140" | 2.27 lb/ft |
| 1-1/2 | 1.900" | 1.610" | 0.145" | 2.72 lb/ft |
| 2 | 2.375" | 2.067" | 0.154" | 3.65 lb/ft |
| 2-1/2 | 2.875" | 2.469" | 0.203" | 5.79 lb/ft |
| 3 | 3.500" | 3.068" | 0.216" | 7.58 lb/ft |
| 3-1/2 | 4.000" | 3.548" | 0.226" | 9.11 lb/ft |
| 4 | 4.500" | 4.026" | 0.237" | 10.79 lb/ft |

# Stainless Steel Pipe Sizes - Schedule 40S Cont’d

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 5 | 5.563" | 5.047" | 0.258" | 14.62 lb/ft |
| 6 | 6.625" | 6.065" | 0.280" | 18.97 lb/ft |
| 8 | 8.625" | 7.981" | 0.322" | 28.55 lb/ft |
| 10 | 10.750" | 10.020" | 0.365" | 40.48 lb/ft |
| 12 | 12.75" | 12.000" | 0.375" | 49.56 lb/ft |
| 14 | 14.000" | 13.250" | 0.375" | 54.57 lb/ft |
| 16 | 16.000" | 15.250" | 0.375" | 62.58 lb/ft |
| 18 | 18.000" | 17.250" | 0.375" | 70.59 lb/ft |
| 20 | 20.000" | 19.250" | 0.375" | 78.60 lb/ft |
| 24 | 24.000" | 23.250" | 0.375" | 94.62 lb/ft |

# d. Stainless Steel Pipe Sizes - Schedule 80S

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 1/8 | 0.405" | 0.215" | 0.095" | 0.32 lb/ft |
| 1/4 | 0.540" | 0.302" | 0.119" | 0.54 lb/ft |
| 3/8 | 0.675" | 0.423" | 0.126" | 0.74 lb/ft |
| 1/2 | 0.840" | 0.546" | 0.147" | 1.09 lb/ft |
| 3/4 | 1.050" | 0.742" | 0.154" | 1.47 lb/ft |
| 1 | 1.315" | 0.957" | 0.179" | 2.17 lb/ft |
| 1-1/4 | 1.660" | 1.278" | 0.191" | 3.00 lb/ft |
| 1-1/2 | 1.900" | 1.500" | 0.200" | 3.63 lb/ft |
| 2 | 2.375" | 1.939" | 0.218" | 5.02 lb/ft |
| 2-1/2 | 2.875" | 2.323" | 0.276" | 7.66 lb/ft |
| 3 | 3.500" | 2.900" | 0.300" | 10.25 lb/ft |
| 3-1/2 | 4.000" | 3.364" | 0.318" | 12.50 lb/ft |
| 4 | 4.500" | 3.826" | 0.337" | 14.98 lb/ft |

# Stainless Steel Pipe Sizes - Schedule 80S Cont'd

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 5 | 5.563" | 4.813" | 0.375" | 20.78 lb/ft |
| 6 | 6.625" | 5.761" | 0.432" | 28.57 lb/ft |
| 8 | 8.625" | 7.625" | 0.500" | 43.39 lb/ft |
| 10 | 10.750" | 9.750" | 0.500" | 54.74 lb/ft |
| 12 | 12.75" | 11.750" | 0.500" | 65.42 lb/ft |
| 14 | 14.000" | 13.000" | 0.500" | 72.09 lb/ft |
| 16 | 16.000" | 15.000" | 0.500" | 82.77 lb/ft |
| 18 | 18.000" | 17.000" | 0.500" | 93.45 lb/ft |
| 20 | 20.000" | 19.000" | 0.500" | 104.10 lb/ft |
| 24 | 24.000" | 23.000" | 0.500" | 125.50 lb/ft |

# e. Polyvinyl Chloride (PVC) Pipe Sizes - Schedule 40

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 1/8 | 0.405" | 0.269" | 0.068" | 0.05 lb/ft |
| 1/4 | 0.540" | 0.364" | 0.088" | 0.09 lb/ft |
| 3/8 | 0.675" | 0.493" | 0.091" | 0.12 lb/ft |
| 1/2 | 0.840" | 0.622" | 0.109" | 0.17 lb/ft |
| 3/4 | 1.050" | 0.824" | 0.113" | 0.23 lb/ft |
| 1 | 1.315" | 1.049" | 0.133" | 0.33 lb/ft |
| 1-1/4 | 1.660" | 1.380" | 0.140" | 0.45 lb/ft |
| 1-1/2 | 1.900" | 1.610" | 0.145" | 0.54 lb/ft |
| 2 | 2.375" | 2.067" | 0.154" | 0.72 lb/ft |
| 2-1/2 | 2.875" | 2.469" | 0.203" | 1.14 lb/ft |
| 3 | 3.500" | 3.068" | 0.216" | 1.49 lb/ft |
| 3-1/2 | 4.000" | 3.548" | 0.226" | 1.79 lb/ft |
| 4 | 4.500" | 4.026" | 0.237" | 2.19 lb/ft |

# Polyvinyl Chloride (PVC) Pipe Sizes - Schedule 40 Cont'd

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 5 | 5.563" | 5.047" | 0.258" | 2.87 lb/ft |
| 6 | 6.625" | 6.065" | 0.280" | 3.73 lb/ft |
| 8 | 8.625" | 7.981" | 0.322" | 5.62 lb/ft |
| 10 | 10.750" | 10.020" | 0.365" | 7.97 lb/ft |
| 12 | 12.75" | 11.938" | 0.406" | 10.53 lb/ft |
| 14 | 14.000" | 13.126" | 0.437" | 12.46 lb/ft |
| 16 | 16.000" | 15.000" | 0.500" | 16.29 lb/ft |
| 18 | 18.000" | 16.876" | 0.562" | 20.59 lb/ft |
| 20 | 20.000" | 18.814" | 0.593" | 24.18 lb/ft |
| 24 | 24.000" | 22.626" | 0.687" | 33.65 lb/ft |

# f. Polyvinyl Chloride (PVC) Pipe Sizes - Schedule 80

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 1/8 | 0.405" | 0.215 | 0.095 | 0.06 lb/ft |
| 1/4 | 0.540" | 0.302" | 0.119" | 0.11 lb/ft |
| 3/8 | 0.675" | 0.423" | 0.126" | 0.15 lb/ft |
| 1/2 | 0.840" | 0.546" | 0.147" | 0.21 lb/ft |
| 3/4 | 1.050" | 0.742" | 0.154" | 0.29 lb/ft |
| 1 | 1.315" | 0.957" | 0.179" | 0.42 lb/ft |
| 1-1/4 | 1.660" | 1.278" | 0.191" | 0.59 lb/ft |
| 1-1/2 | 1.900" | 1.5" | 0.200" | 0.71 lb/ft |
| 2 | 2.375" | 1.939" | 0.218" | 0.98 lb/ft |
| 2-1/2 | 2.875" | 2.323" | 0.276" | 1.50 lb/ft |
| 3 | 3.500" | 2.900" | 0.300" | 2.10 lb/ft |
| 3-1/2 | 4.000" | 3.364" | 0.318" | 2.45 lb/ft |
| 4 | 4.500" | 3.826" | 0.337" | 2.94 lb/ft |

# Polyvinyl Chloride (PVC) Pipe Sizes - Schedule 80 Cont'd

| NPS | OD (Inch) | ID (Inch) | SCHEDULE (Inch) | WEIGHT (Lb/Ft) |
|---|---|---|---|---|
| 5 | 5.563" | 4.813" | 0.375" | 4.08 lb/ft |
| 6 | 6.625" | 5.761" | 0.432" | 5.61 lb/ft |
| 8 | 8.625" | 7.625" | 0.500" | 8.52 lb/ft |
| 10 | 10.750" | 9.562" | 0.594" | 12.64 lb/ft |
| 12 | 12.75" | 11.374" | 0.688" | 17.38 lb/ft |
| 14 | 14.000" | 12.500" | 0.750" | 20.85 lb/ft |
| 16 | 16.000" | 14.312" | 0.844" | 26.81 lb/ft |
| 18 | 18.000" | 16.124" | 0.938" | 33.54 lb/ft |
| 20 | 20.000" | 17.938" | 1.031" | 41.05 lb/ft |
| 24 | 24.000" | 21.562" | 1.219" | 58.23 lb/ft |

First, we need to admit that all pipe size should be identified as nominal pipe size (NPS). Second, for NPS 1/8 (DN 6) to NPS 12 (DN 300), these are based on a standard outside diameter (O.D.) This O.D. was originally selected to specify pipe dimension, but as the pipe always have an wall thickness and internal diameter (ID). For small pipe, there is a different size between OD and ID (Wall thickness), but as the pipe dimensions became larger, the OD and ID approximately to become equal.

These sizes are based on an approximation and are not characteristic of the exact diameter of the pipe. For example, the actual diameter of a pipe that has a nominal bore of two inches isn’t exactly two inches or 50.8 millimeters, but 2.37″ or 60.3 mm. This means that there is always a standard corresponding value for each nominal bore category, indicating the pipe’s outer diameter. Engineers can find that value in data tables and never try to follow a “data reduction” approach as this won’t work in this case.

The schedule rating categories that indicate the wall thickness range from 5 to 160, indicating an increasing thickness value. It is also important to note that for practical reasons, the edge of pipes are often colored according to their schedule rating and this is also standardized. Green corresponds to extra light thickness, yellow corresponds to light thickness, blue to medium, red to heavy, and white to extra heavy wall thickness.

To relate these with the schedule ratings, the medium is schedule – 40, and the heavy is schedule – 80.

Of course, the higher the thickness the higher the weight, and this very important consideration can also be attained by data tables provided by the pipe manufacturer.

NPS, OD, ID and Schedule are essential parameters of pipe dimensions. Depending on the types of material from which a pipe is made from, the aforementioned parameters are different from one material to another even if dimensions could be the same. It is clear that schedule represents the real pipe thickness to resist the amount of the fluid pressure inside the pipe which means for different materials they are capable of withstanding different maximum amount of pressure.

# THANK YOU!!!!!!!!!!

# Q&A

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