TA201T: Introduction to Manufacturing Processes I

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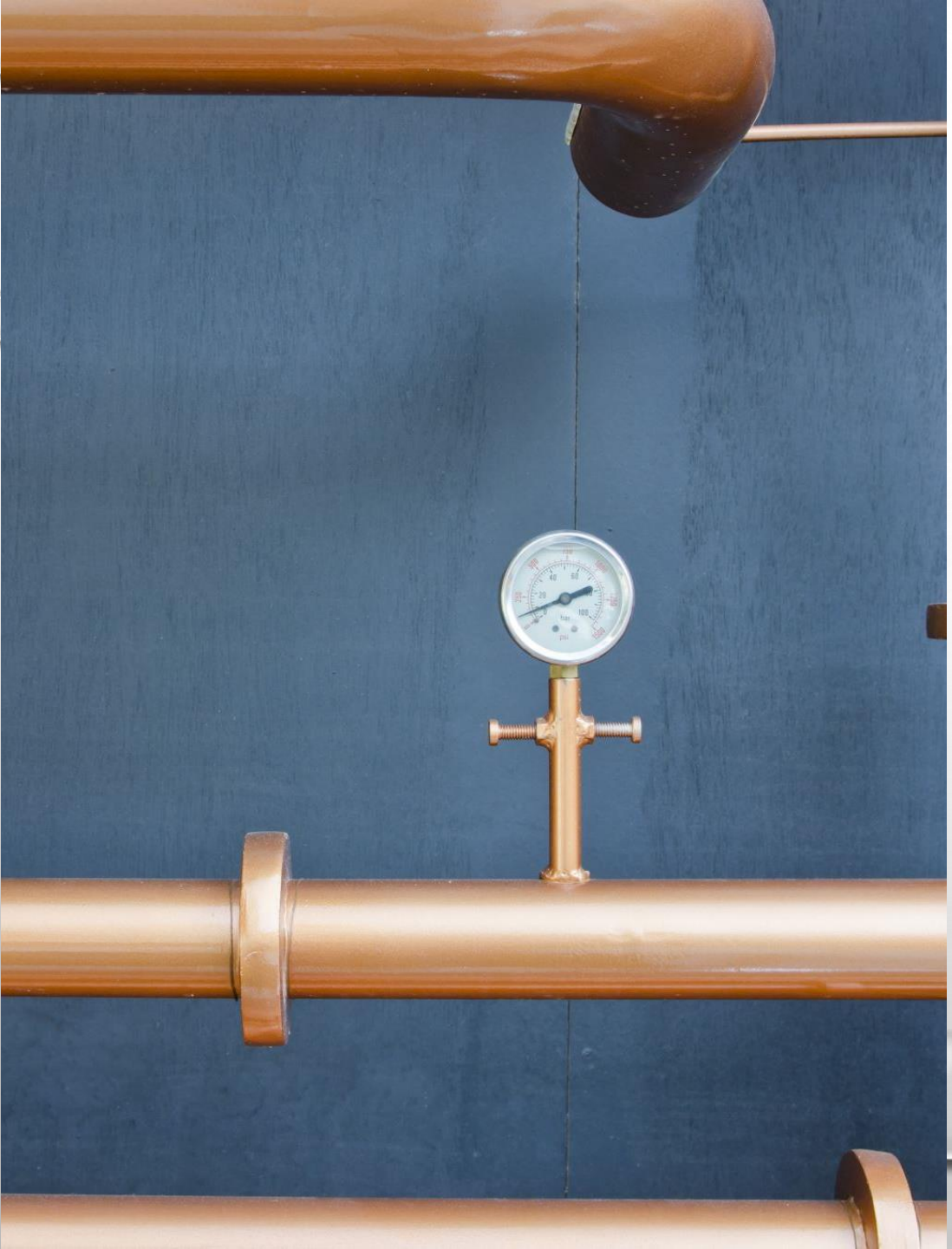


STAINLESS STEEL DIVING CYLINDER

LET'S DO A DEEP DIVE INTO IMMENSE OCEAN OF TA201

DIVING CYLINDER – AN INTRODUCTION

- A **DIVING CYLINDER** IS A GAS CYLINDER USED TO STORE AND TRANSPORT THE HIGH PRESSURE BREATHING GAS.
- THERE ARE DIFFERENT TYPES OF DIVING CYLINDER , THEY DIFFER IN MATERIALS USED. SOME ARE MADE UP OF STAINLESS STEEL AND OTHERS OF ALUMINIUM .
- **STEEL DIVING CYLINDERS ARE HEAVY AND ARE USED FOR DEEP DIVING .**

HISTORY

- IN 1942, DURING THE GERMAN OCCUPATION OF FRANCE, JACQUES-YVES COUSTEAU AND EMILE GAGNAN DESIGNED THE FIRST SUCCESSFUL AND SAFE OPEN-CIRCUIT **SCUBA**, KNOWN AS THE AQUA-LUNG.
- THEIR SYSTEM COMBINED AN IMPROVED DEMAND REGULATOR WITH HIGH-PRESSURE AIR TANKS. ...EARLY SCUBA DIVERS DIVED WITHOUT A BUOYANCY AID.
- STEEL **CYLINDERS** ARE **MADE** USING A PROCESS CALLED "DEEP DRAW".

PRESENT TIMES DIVING CYLINDERS

- 3 LITRE - SO-CALLED PONY CYLINDERS BECAUSE OF THEIR SMALL SIZE.
- ALUMINIUM S40 - 5.7-LITRE SCUBA DIVING CYLINDER USED MAINLY IN THE AMERICAS AND THE CARIBBEAN AS A STAGE OR DECOMPRESSION TANKS OR A REBREATHER TANKS.
- 7 LITRE - STEEL DIVING CYLINDER USED FOR TRAINING OR A PETITE PERSON. MAIN APPLICATION NOWADAYS IS AS BAILOUT TANKS IN REBREATHER DIVING OR DECOMPRESSION OR STAGE TANKS IN TECHNICAL DIVING.
- 10 LITRE - STEEL DIVE CYLINDER USED IN SCUBA DIVING FOR SMALLER BUILD PERSON OR USED AS S BAILOUT BOTTLE OR DECOMPRESSION AND STAGE TANKS IN TECHNICAL DIVING.
- 12 LITRE - STEEL 12 LITRE DIVING CYLINDER IS THE MOST POPULAR TANK SIZE IN RECREATIONAL DIVING. IT IS WIDELY USED BY DIVE CENTRES AND LIVEABOARDS WORLDWIDE. TWIN MANIFOLDED 12S ARE A POPULAR CHOICE IN TECHNICAL DIVING.
- 15 LITRE - SCUBA DIVING CYLINDER USED EXTENSIVELY IN THE UK IN SINGLE TANK DIVING. TWIN 15-LITRE TANKS CAN BE PAIRED TOGETHER WITH A MANIFOLD VALVE FOR TWINSET DIVING.

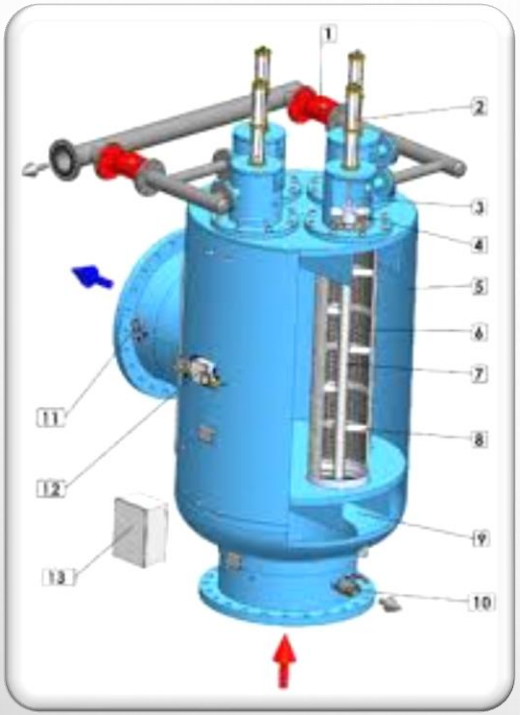
STEEL COMPOSITION

- **STAINLESS STEELS** ARE **STEELS** CONTAINING AT LEAST 10.5% CHROMIUM, LESS THAN 1.2% CARBON AND OTHER ALLOYING ELEMENTS. **STAINLESS STEEL'S** CORROSION RESISTANCE AND MECHANICAL PROPERTIES CAN BE FURTHER ENHANCED BY ADDING OTHER ELEMENTS, SUCH AS NICKEL, MOLYBDENUM, TITANIUM, NIOBIUM, MANGANESE, ETC.

	Type 304	Type 316
Carbon	0.08% max.	0.08% max.
Manganese	2.00% max.	2.00% max.
Phosphorus	0.045% max.	0.045% max.
Sulfur	0.030% max.	0.030% max.
Silicon	1.00% max.	1.00% max.
Chromium	18.00-20.00	16.00-18.00
Nickel	8.00-10.50%	10.00-14.00
Molybdenum	-	2.00-3.00%

STEEL MANUFACTURING

- A SCUBA TANK'S CAPACITY IS DETERMINED BY ITS SIZE AND PRESSURE RATING. MOST TANKS HAVE CAPACITIES RANGING FROM 50 TO 120 CF, WITH VARIOUS COMPRESSED AIR PRESSURES: LOW-PRESSURE (LP) WITH 2400-2650 PSI, STANDARD PRESSURE WITH 3000 PSI, AND HIGH-PRESSURE (HP) AT 3300-3500 PSI.
- IF YOU PREFER A HIGHER PRESSURE TANK, STEEL IS USUALLY THE IDEAL CHOICE.
- STEEL TANKS CAN ALSO BE DAMAGED IF MOISTURE IS INTRODUCED DURING THE FILL PROCESS, AS THIS CAN CAUSE OXIDATION LATER ON .
- THE MAJOR COMPONENT OF STEEL IS IRON, A METAL THAT IN ITS PURE STATE IS NOT MUCH HARDER THAN COPPER .



DIVING CYLINDER SECTIONAL VIEW

MATERIAL COMPONENTS

- THE FUNCTIONAL DIVING CYLINDER CONSISTS OF A PRESSURE VESSEL AND A CYLINDER VALVE. THERE ARE USUALLY ONE OR MORE OPTIONAL ACCESSORIES DEPENDING ON THE SPECIFIC APPLICATION.
- **PRESSURE VALVE**
- 1THE PRESSURE VESSEL IS A SEAMLESS CYLINDER NORMALLY MADE OF COLD-EXTRUDED ALUMINIUM OR FORGED STEEL.
- **CYLINDRICAL VALVE**
- 2 THE PURPOSE OF THE *CYLINDER VALVE* IS TO CONTROL GAS FLOW TO AND FROM THE PRESSURE VESSEL AND TO PROVIDE A CONNECTION WITH THE REGULATOR OR FILLING HOSE.

CREATING CYLINDERS

- CREATING A SCUBA CYLINDER IS NO MINOR FEAT, AND IT REQUIRES A GREAT DEAL OF PRESSURE. STEEL CYLINDERS ARE MADE USING A PROCESS CALLED “DEEP DRAW,” WHILE ALUMINUM CYLINDERS ARE MADE BY “BACKWARD EXTRUSION.”

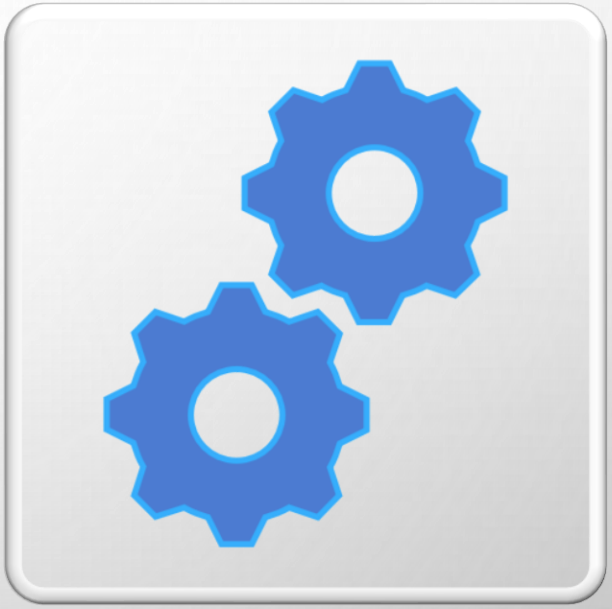
- AFTER THE MATERIAL IS PUT THROUGH A SERIES OF PUNCHES AND DIES, THE RESULT IS A SHELL THAT RESEMBLES A LARGE COFFEE CUP. IN BOTH PROCESSES, HEAT IS APPLIED TO THE TOP OR NECK OF THE CYLINDER TO CREATE A NARROW OPENING, WHICH IS THEN THREADED FOR INSERTION OF THE CYLINDER VALVE.

- PST, WHICH HAS BEEN MANUFACTURING SCUBA CYLINDERS SINCE 1951, USES A HOT DIP GALVANIZING PROCESS TO CREATE A PROTECTIVE COATING ON ITS CYLINDERS.

- AS PART OF THE MANUFACTURING PROCESS, THE CYLINDER IS TESTED FOR DEFECTS.

MANUFACTURING CYLINDRICAL VALVES

- THE VALVE IS AN INTEGRAL PART OF THE CYLINDER.
- ONE FEATURE COMMON TO ALL CYLINDER VALVES IS A PRESSURE RELIEF DEVICE (PRD), ALSO KNOWN AS A BURST DISK.
- THIS TINY, FRANGIBLE DISK IS DESIGNED TO BREAK AND RELEASE THE PRESSURE WITHIN THE CYLINDER WHEN IT REACHES A CRITICAL PRESSURE .
- THIS CAN HAPPEN AS A RESULT OF OVERFILLING, OR DUE TO AN INCREASE IN THE TEMPERATURE OF THE CYLINDER.



TANKING UP

It’s important to get a good (and safe) air fill.

The service pressure for the cylinder assumes a temperature of 70 degrees Fahrenheit (21 degrees Celsius), so even a properly filled cylinder will show higher (if hot) or lower (if cold), depending on the temperature.

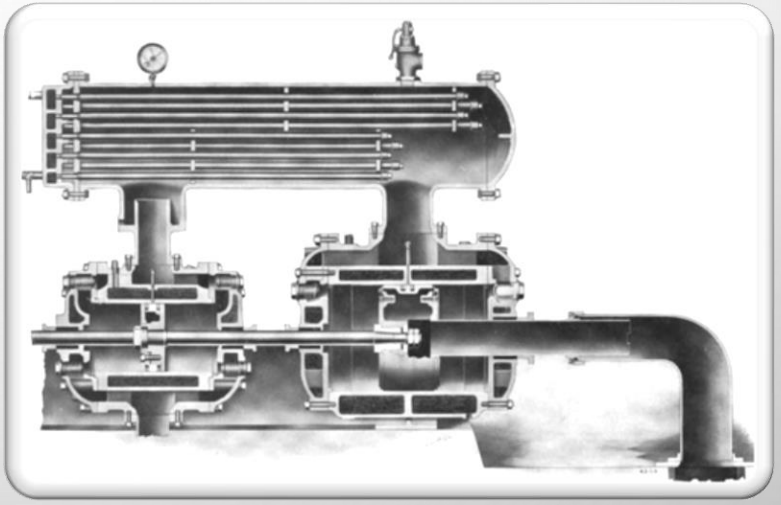
It’s just too easy for water to be forced into your cylinder during the filling process, and that can spell both corrosion and air quality problems. Finally, the fill shouldn’t be done too quickly. NOAA recommends a fill rate of 300-600 psi per minute to prevent excessive heating during the fill.

TEMPERATURE CHANGE DURING FILLING (1/2)

- COMPRESSION OF AMBIENT AIR CAUSES A TEMPERATURE RISE OF THE GAS, PROPORTIONAL TO THE PRESSURE INCREASE. AMBIENT AIR IS TYPICALLY COMPRESSED IN STAGES, AND THE GAS TEMPERATURE RISES DURING EACH STAGE. INTERCOOLERS AND WATER COOLING HEAT EXCHANGERS CAN REMOVE THIS HEAT BETWEEN STAGES.
- CHARGING AN EMPTY DIVE CYLINDER ALSO CAUSES A TEMPERATURE RISE AS THE GAS INSIDE THE CYLINDER IS COMPRESSED BY THE INFLOW OF HIGHER PRESSURE GAS, THOUGH THIS TEMPERATURE RISE MAY INITIALLY BE TEMPERED BECAUSE COMPRESSED GAS FROM A STORAGE BANK AT ROOM TEMPERATURE DECREASES IN TEMPERATURE WHEN IT DECREASES IN PRESSURE, SO AT FIRST THE EMPTY CYLINDER IS CHARGED WITH COLD GAS, BUT THE TEMPERATURE OF THE GAS IN THE CYLINDER THEN INCREASES TO ABOVE AMBIENT AS THE CYLINDER FILLS TO THE WORKING PRESSURE.
- EXCESS HEAT CAN BE REMOVED BY IMMERSION OF THE CYLINDER IN A COLD WATER BATH WHILE FILLING.

TEMPERATURE CHANGE DURING FILLING (2/2)

- AN **INTERCOOLER** IS A MECHANICAL DEVICE USED TO COOL A GAS AFTER COMPRESSION.
- CYLINDERS MAY ALSO BE FILLED WITHOUT WATER-BATH COOLING, AND MAY BE CHARGED TO ABOVE THE NOMINAL WORKING PRESSURE TO THE DEVELOPED PRESSURE APPROPRIATE TO THE TEMPERATURE WHEN FILLED. AS THE GAS COOLS TO AMBIENT TEMPERATURE, THE PRESSURE DECREASES, AND WILL REACH RATED CHARGING PRESSURE AT THE RATED TEMPERATURE.



REFERENCES

- HTTPS://EN.WIKIPEDIA.ORG/WIKI/DIVING_CYLINDER

- HTTPS://EN.WIKIPEDIA.ORG/WIKI/INTERCOOLER

- HTTPS://DTMAG.COM/THELIBRARY/INSIDE-LOOK-AT-SCUBA-CYLINDERS/#:~:TEXT=CREATING%20CYLINDERS&TEXT=STEEL%20CYLINDERS%20ARE%20MADE%20USING,RESEMBLES%20A%20LARGE%20COFFEE%20CUP.