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# SCENARIUSZ LEKCJI

**Przedmiot**: Posługiwanie się dokumentacją techniczną

**Poziom edukacyjny:** II klasa szkoły ponadgimnazjalnej

**Podstawa programowa:** dla zawodu technik technologii chemicznej

**Temat**: Charakterystyka materiałów konstrukcyjnych rur hydraulicznych

**Treści programowe**:
Uczeń:
- wymienia rodzaje materiałów konstrukcyjnych,
- opisuje właściwości materiałów konstrukcyjnych.

**Cel lekcji**: zapoznanie ucznia z rodzajami materiałów budujących rury hydrauliczne, charakterystyka właściwości użytkowych i fizykochemicznych.

**Cele operacyjne lekcji**:

**- uczeń wymieni**:
- ✓ Rodzaje materiałów konstrukcyjnych,
- ✓ Właściwości fizykochemiczne materiałów,

**- uczeń scharakteryzuje:**
- ✓ właściwości użytkowe i fizykochemiczne rur stalowych, miedzianych, żeliwnych, szklanych, z tworzyw sztucznych PP, PE, PCV, PB.

**- uczeń przetłumaczy:**
- ✓ tekst z języka angielskiego,

**- uczeń wykona:**
- ✓ referat obejmujący:
- charakterystykę materiału konstrukcyjnego w języku angielskim i polskim,
- ilustrację danego rodzaju rur,
- właściwości fizykochemiczne danego rodzaju rur,
- zastosowanie danego typu rur w przemyśle chemicznym.

**- uczeń będzie umiał**:
- ✓ scharakteryzować rodzaje rur i ich właściwości.

**Typ lekcji:** ćwiczenie

**Metody pracy:** praca z tekstem źródłowym w języku angielskim, praca ze słownikiem angielsko-polskim, praca z programem do edycji tekstu, gra Kahoot.

**Media dydaktyczne**: zestaw komputerowy, Internet, program do edycji tekstu.

**Plan lekcji**:

1. Powitanie, sprawdzenie obecności, podanie tematu lekcji, przedstawienie celu lekcji i jej przebiegu.
2. Wprowadzenie do zajęć, pogadanka nt. rodzaju i funkcji norm branżowych i Polskich Norm.
3. Zapoznanie się z dokumentem normy PN-EN ISO 10628:2005.

4. Podział zadań (każdy dostaje wylosowaną grupę symboli graficznych).
5. Tłumaczenie na język angielski.
6. Tworzenie plakatu.
7. Podsumowanie.

**Szczegółowy plan lekcji**:

| Czas | Działanie |
|---|---|
| 0 - 5 min | Powitanie, sprawdzenie obecności, podanie tematu lekcji, przedstawienie celu lekcji i jej przebiegu. |
| 6 - 10 min | Wprowadzenie do zajęć. |
| 11 - 80 min | Tłumaczenie nazw urządzeń i armatury systemów technologii chemicznej. Tworzenie plakatów. |
| 80 - 90 min | Podsumowanie. Gra Kahoot https://create.kahoot.it/share/basic-material-properties/9d364237-3214-40cb-8e28-93652ca9593d |

Tekst źródłowy:

Basic material properties

1 **Steel** is strong, rigid, and has a low coefficient of thermal expansion. It is also heavy (multiple workers may be needed to transport it) and is subject to corrosion. Sometimes it is called carbon steel or black steel to differentiate from stainless and galvanized steel. All steel, by definition, contains carbon.

Steel often is used for closed hydronic systems because it is inexpensive, especially when compared with other materials in systems with high pressures, and corrosion is relatively easily controlled in these systems. It also is a good choice for steam and steam-condensate systems because it handles high temperatures and pressures well, and corrosion is normally not an issue in steam pipes. However, corrosion is an issue in steam-condensate pipes, and many engineers specify schedule 80 steel pipe simply because it takes about twice as long to rust through as schedule 40 pipe. If amines (commonly cyclohexylamine, morpholine, or diethylethanolamine (DEAE) are fed properly to neutralize condensate pipe pH, condensate pipes can last the life of the building. Some building owners do not want these chemicals in steam that may be used for humidification because of health concerns; however, not using these amines might require a change to stainless steel (SS) piping or adding a separate “clean steam” system for humidification and for sterilization of medical instruments. Steel pipe is removed from a pool of zinc during the hot-dip galvanizing process. Courtesy: American Galvanizers Association Rigidity is important because it determines the distance between hangers. Steel pipe is manufactured in 21-ft lengths, and the hangers can be spaced that widely for large-diameter pipe. More flexible materials, however, may require hangers on as close as 4-ft centers or even continuously. A low coefficient of thermal expansion minimizes the need for expansion loops and expansion joints. However, the high rigidity of steel means that although it expands less, it exerts very high forces on anchors.

2. **Galvanized steel** pipe is steel pipe that is dipped into a pool of zinc. Galvanizing has two methods of corrosion reduction. It coats the surface like paint, and under most circumstances it forms a very adherent oxide layer like aluminum and SS. It provides a sacrificial anode (zinc) to receive corrosion instead of the steel corroding. Galvanized steel pipe has all the advantages of steel pipe, plus improved corrosion resistance in most environments, although at a slightly higher cost. Galvanizing works almost perfectly in applications where it is wetted and dried periodically (e.g., road signs and guard rails). It can fail in environments with high sodium (e.g., softened water that started out very hard) because the sodium makes the adherent oxide film detach and react more like steel pipe where the oxide flakes off. If galvanized pipe is being welded, the welder needs to be careful to grind down to the raw steel. Repairing galvanizing on the

inside of the pipe is difficult or impossible. If the interior needs a continuous galvanized layer, consider mechanical couplings.

**Copper pipe** often is used in both hydronic and domestic applications, especially for 2-in. and smaller pipe sizes. However, some contractors propose replacing galvanized steel domestic-water pipe with copper up to 6-in. in size, especially in the Midwest. Copper is an expensive material but has the advantage of weighing less than steel and may require fewer employees to install, depending on weight and union restrictions. Also, copper is generally more noble and corrosion-resistant than steel or galvanized steel. In the HVAC industry, most copper is Type L (medium thickness) hard (tempered) copper, although underground soft (annealed) copper is often Type K (thick). Drain, waste, and vent (DWV) piping is thinner (Type M).

3 **Stainless steel** is widely considered to be resistant to all corrosion. This is true in many circumstances, but not all. Anaerobic and chloride corrosion can affect SS. The most common alloy is 304 SS, which adds 18% chromium and 8% nickel to steel. 304L has reduced carbon content to minimize the tendency for SS to corrode at welds. SS with the L designation is recommended for all SS that will be welded and might have corrosion issues, like fume exhaust and some pipe systems. 316 and 316L add molybdenum to reduce susceptibility to chlorides.

In the past decade, we have seen thinner SS being proposed as an alternative to galvanized steel pipe and larger-diameter copper pipe, primarily for domestic potable-water piping.

## Selecting pipe material for specific applications

| Property | Application and pipe material rating | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5=Highest 1=Lowest | Application Importance | Steel | Galvanized Steel | Stainless Steel | Copper | PVC | CPVC | PP | PVDF | PEX | FRP |
| Cost | 5 | 4 | 3 | 2 | 3 | 5 | 5 | 4 | 2 | 5 | 3 |
| Rigidity | 2 | 5 | 5 | 5 | 4 | 2 | 2 | 2 | 2 | 1 | 3 |
| Strength | 2 | 5 | 5 | 5 | 4 | 2 | 2 | 2 | 2 | 1 | 3 |
| Corrosion | 3 | 1 | 2 | 4 | 3 | 5 | 4 | 5 | 5 | 4 | 4 |
| Flammability | 2 | 5 | 5 | 5 | 5 | 2 | 3 | 1 | 4 | 2 | 2 |
| UV resistance | 1 | 5 | 5 | 5 | 5 | 2 | 2 | 1 | 2 | 1 | 3 |
| Purity | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 5* | 3 | 3 |
| **Total** | – | **59** | **58** | **60** | **58** | **58** | **57** | **51** | **48** | **49** | **49** |

Pipe material property ratings are estimates and purely the authors' opinions. The "Importance" column is intended for the user to rate each property for a specific application. Totals are based on multiplying each property's rating by each material's property factor and adding. For a copy of the editable spreadsheet, email Jeff.G.Boldt@IMEGcorp.com. * PVDF is great for pure water and passes 25/50, but is expensive.

*Table 1: This information is based off personal data and research, and it provides a framework for each engineer or firm to evaluate the best material for their piping systems. Courtesy: IMEG Corp. SS requires some oxygen to build an adhering oxide layer, like aluminum car wheels. This is normally not a problem in hydronic heating/cooling systems or domestic-water systems, but a large chilled-water-storage system could have oxygen levels become low enough to have issues with microbially influenced corrosion (known as MIC).*

There are many grades of SS. In general, 300 series alloys are the most corrosion-resistant and are nonmagnetic. 400 series are harder, more resistant to abrasion, withstand higher temperatures, and are magnetic. 200 series alloys are used in sinks and applications where less corrosion resistance is acceptable. Stainless steel is a versatile material comprised of a steel alloy and a small percentage of chromium — the addition of chromium adds to the material's corrosion resistance, a trait that earned stainless steel its name. Because stainless steel is also low-maintenance, oxidation resistant, and doesn't affect other metals it comes in contact with, it is frequently used in a large array of applications, especially in piping and tubing manufacturing. Based on the end use of the pipe, stainless steel piping is broken down into several categories.

**4** **Cast iron (CI)** is used primarily in sewer and stormwater systems. It has very good corrosion resistance in these applications. The disadvantage is that the most common joints are not restrained. Most cast iron joints are either push-on or no-hub. Push-on joints work very well underground where the soil pressure helps stop the pipe from moving. Above ground, however, there are risks that the pipe may separate if there is a blockage and the pressure becomes too high. Galvanized steel, primarily for storm systems, with mechanical couplings or plastic-bonded piping can be specified when a risk of flooding due to pressure seems possible.

Cast iron pipe is manufactured by the pit, horizontal or centrifugal method. In the vertical pit method, a mold is made by ramming sand around a pattern and drying the mold in an oven. A core is inserted in the mold and molten iron is poured between the core and the mold. In the horizontal method, a machine is used to ram sand around horizontal molds that have core bars running through them. The molten iron is poured into the molds from multiple-lipped ladle designed to draw the iron from the bottom to eliminate the introduction of impurities.

**Ductile iron** (DI) is like cast iron, except that it has a lower percentage of carbon and has annealing and/or additives, such as magnesium, to form a different (nodular) matrix. This makes it stronger and more ductile than cast iron. Its corrosion resistance is very similar to cast iron. DI is commonly used for city water mains. For storm or sanitary sewers, one length of DI pipe passing under footings can be specified so that, if the structure settles, the pipe will bend and not break.

**5** **Polyvinylchloride (PVC)** piping is often used in residential applications and is becoming more popular in commercial/industrial applications. It has the advantage of being very resistant to most corrosion, but not to solvents or some oils. Some manufacturers use polyolester (POE) oil to clean HVAC coils, and, in some instances, caused cracking of PVC condensate drain pipes. Chlorinated polyvinylchloride (CPVC) and acrylonitrile butadiene styrene (ABS) also are highly incompatible with POE oils.

One concern about PVC and CPVC is that they contain chlorine. When chlorine burns, it creates mustard gas. While deaths have not been caused by burning pipe in buildings giving off chlorine gas, they have read at least one article about a burning PVC copy machine that resulted in deaths of firefighters. The biggest concerns about PVC are close hanger spacing and not complying with the 25/50 flame spread/smoke developed rating per NFPA 255: Standard Method of Test of Surface Burning Characteristics of Building Materials and ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials, which building codes require for materials located in return-air plenums. This is also true of polypropylene and most formulations of CPVC. CPVC is basically PVC with a cross-linked chlorine molecule added to give it higher temperature resistance. It is commonly used in domestic hot-water systems. One disadvantage of PVC, CPVC, and most plastic and some fiber-reinforced plastic (FRP) piping systems is that they have very short radius fittings, therefore they have higher pressure-drop coefficients.

**Polyvinylidene fluoride** (PVDF) is a fluoropolymer that is related to Teflon. It is expensive but has excellent properties. It can withstand 212°F liquids, passes the 25/50 flame spread/smoke developed rating for return-air plenums (and is used for the interior liner of city buses because it will not burn like other plastics), and is very inert (i.e., it can be used for the highest-purity water laboratory or microchip systems).

**6** **Polypropylene** is known as olefin in the carpet industry, where it is used for indoor/outdoor carpet. PP has the advantage of handling fluids up to 210°F and being very resistant to corrosion. Some firms use it for acid waste and (in no-additives form) for pure water systems. It is also used for some dairy waste piping where 210°F water may go down the drain to clear solidified cheese. In general, PP is the most corrosion-resistant of all materials other than PVDF and other Teflon derivatives.

Polypropylene is suitable for use with foodstuffs, potable and ultra pure waters, as well as within the pharmaceutical and chemical industries. PP is a thermoplastic polymer made from polypropylene. It was first invented in the 1950s and has been used for pipes since the 1970s. Due to the high impact resistance combined with good stiffness and high chemical resistance makes this material suitable for sewer

applications. A good performance at operating temperature range from up to 60 °C (140 °F) (continuous) makes this material suitable for in-house discharge systems for soil & waste. A special PP grade with high temperature behaviour up to 90 °C (194 °F) (short-term) makes that material a good choice for in-house warm water supply.

**PB-1 (polybutylene)**

PB-1 is used in pressure piping systems for hot and cold potable water, pre-insulated district heating networks, and surface heating and cooling systems. Key properties are weldability, temperature resistance, flexibility and high hydrostatic pressure resistance. One standard type, PB 125, has a minimum required strength (MRS) of 12.5 MPa. It also has low noise transmission, low linear thermal expansion, no corrosion and calcification.

PB-1 piping systems are no longer sold in North America. Market share in Europe and Asia is small but steadily growing. In some markets, e.g. Kuwait, UK, Korea and Spain, PB-1 has a strong positio

FRP is useful for applications where corrosion resistance, ultraviolet (UV) resistance, and more rigidity than plastics are desirable. It has varying corrosion-resistance and strength properties depending on the plastic and the fiber used, and how the fiber is oriented. Many products allow choosing various inner coatings to resist particular chemicals. Cooling tower piping is a good HVAC application, provided that the product has low-loss coefficient fittings.

**7 PE (polyethylene)**

Polyethylene has been successfully used for the safe conveyance of potable and waste water, hazardous waste, and compressed gases for many years. Two variants are HDPE Pipe (high-density polyethylene)[8] and the more heat resistant PEX (cross-linked polyethylene, also XLPE).

PE has been used for pipes since the early 1950s. PE pipes are made by extrusion in a variety of sizes dimensions. PE is lightweight, flexible and easy to weld. Its smooth interior finish ensures good flow characteristics. Continuous development of the material has enhanced its performance, leading to rapidly increasing usage by major water and gas utility companies throughout the world.

The pipes are also used in lining and trench-less technologies, the so-called no-dig applications where the pipes are installed without digging trenches without any disruption above ground. Here the pipes may be used to line old pipe systems to reduce leakage and improve water quality. These solutions are therefore helping engineers to rehabilitate antiquated pipe systems. Excavation is minimal and the process is carried out quickly below ground. Also for PE pipe material, several studies demonstrated the long track record with expected lifetime of more than 50 years. Cross-linked polyethylene is commonly referred to as XLPE or PEX. It is a thermoplastic material that can be made in three different ways depending how the cross-linking of the polymer chains is being made. PEX was developed in the 1950s. It has been used for pipes in Europe since the early 1970s and has been gaining rapid popularity over the last few decades. Often supplied in coils, it is flexible and can therefore be led around structures without fittings. Its strength at temperatures ranging from below freezing up to almost boiling makes it an ideal pipe material for hot and cold water installations, radiator and under floor heating, de-icing and ceiling cooling applications

**8 PEX** (polyethylene cross-linked) piping has become very popular, especially in residential plumbing systems. It is a clear, flexible piping material and some formulations comply with 25/50 flame/smoke requirements for location in return-air plenums. It is very flexible, requiring frequent or continuous support.

**PE RT** Polyethylene of raised temperature resistance or PE-RT expands the traditional properties of polyethylene. Enhanced strength at high temperatures are thus made possible through special molecular design and manufacturing process control. Its resistance to low or high temperatures makes PE-RT ideal for a broad range of hot and cold water pipe applications.

**Borosilicate glass** was once a popular laboratory waste piping material. It has high resistance to corrosion but is expensive and potentially can have issues if very hot water is poured down the drain. It is not typically

used in modern labs. Glass tubes are mainly cylindrical hollow-wares. Their special shape combined with the huge variety of glass types (like borosilicate, flint, aluminosilicate, soda lime, lead or quartz glass), allows the use of glass tubing in many applications. For example, laboratory glassware, lighting applications, solar thermal systems and pharmaceutical packaging to name the largest.

Compared to other materials like plastics the importance of cylindrical half-finished products in glass is high. Main reasons are the difficulty associated with 3-d forming of glass in general. In order to create hollow objects from glass the cylinder shape is a natural starting material.

Cylindrical glass tubes have:

• the lowest surface area and most compact design
• highest mechanical strength against pressure and impact
• automated further processing due to symmetry.

Compared to moulded glass ware the process of tube drawing achieves:

• better optical clarity
• more homogeneous distribution of wall thickness
• higher precision or volume and geometry in general.