Al-Mustaqbal University College
Department of anesthesia

Lecture of anesthesia equipment

Teaching by

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CENTRAL PIPELINE SYSTEMS

Nonflammable gases, such as O2, N2O, Air, CO2, and N2 can be delivered to operating rooms and other patient care areas via central piping system. Central piping systems are installed by contractors or suppliers dealing with medical gas pipelines and are maintained by the bioengineering or the maintenance department of the healthcare institute. The most important aspect of centralized medical gas pipeline systems for any hospital to ensure supply of medical gases/vacuum at each outlet point at desired pressure and flow.

Gases from the central manifold are fed into labeled and color-coded pipeline distribution network, which terminates in self-sealing non-interchangeable sockets either as diameter-index safety system (DISS), non-interchangeable screw threads (NIST) or as non-interchangeable quick couplers (NIQC) at the user point as wall outlets, ceiling pendants, ceiling columns or bed head panels.

Piped O2 is provided from a central O2 source, which may be in the gaseous form, i.e. a cylinder manifold, gas in manifold cylinders on a trailer or pallet; or in the liquid form, i.e. a vacuum insulated evaporator or an O2 concentrator. Piped medical air may be supplied from either a cylinder manifold or a compressor with an outlet filter. Nitrous oxide is generally supplied from a cylinder manifold.

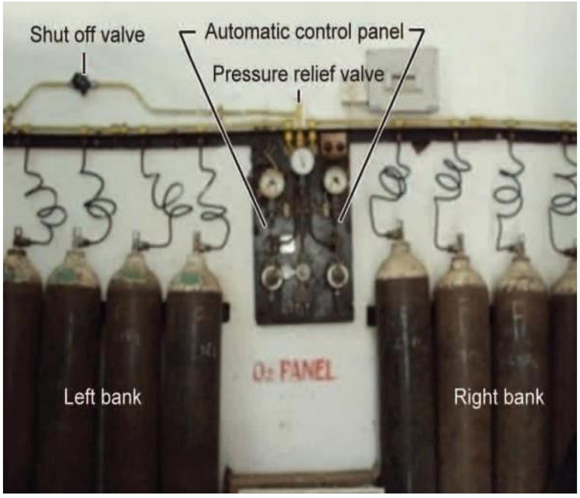
Components of Central Piping System:

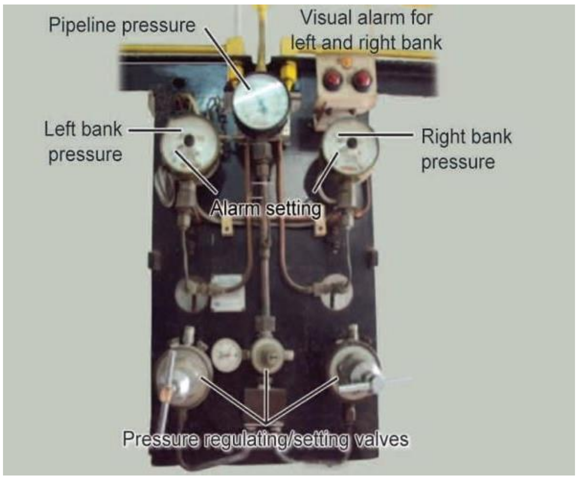
• Source equipment: Central manifold containing cylinders, liquid tank or central plant containing generators for piped compressed air and vacuum

• Pipeline distribution system: Piping emerging out from source equipment and extending to locations where the gas may be required

• Terminal units: Wall outlets, ceiling pendants and bed head panels at the user points

• Suction and O2 therapy products.





Note1: Manifolds are two banks (one right sided bank and one left sided bank) Large cylinders (e.g. size J each with 6800 L capacity) are usually divided into two equal groups, primary and secondary. The number of cylinders depends on the expected demand.

Note2: All cylinders in each group are connected through non-return valves to a common pipe. This in turn is connected to the pipeline through pressure regulators.

Note3: In either group, all the cylinders' valves are opened. This allows them to empty simultaneously .The supply is automatically changed to the secondary group when the primary group is nearly empty. The changeover is achieved through a pressure sensitive device that detects when the cylinders are nearly empty .The changeover activates an electrical signalling system to alert staff to the need to change the cylinders.

Problems in practice and safety features

1. The manifold should be housed in a well-ventilated room built of fireproof material away from the main buildings of the hospital.

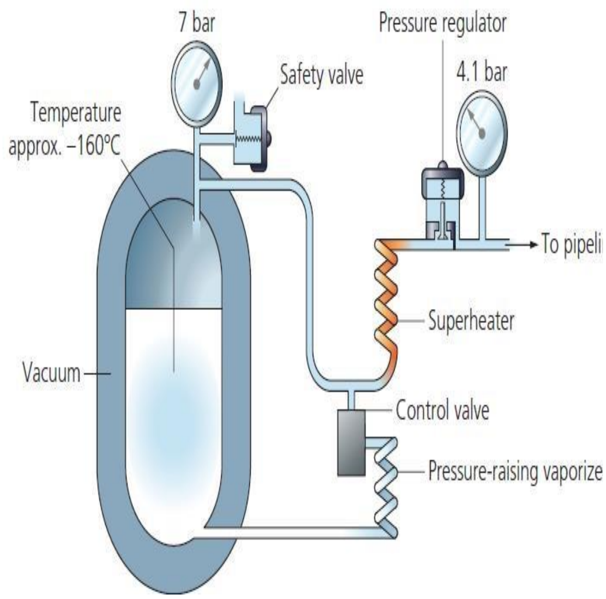
2. The manifold room should not be used as a general cylinder store.

3. All empty cylinders should be removed immediately from the manifold room.

Note: Anaesthetists are responsible for the gases supplied from the terminal outlet through to the anaesthetic machine. Pharmacy, supplies and engineering departments share the responsibility for the gas pipelines 'behind the wall'.

Liquid Oxygen Supply:

Liquid O2 containers are installed when large amounts of O2 are required. A vacuum-insulated evaporator (VIE) is the most economical way to store and supply oxygen.



Important notes for liquid oxygen:

Note1: Liquid oxygen is stored (up to 1500 L) at a temperature of −150° to −170°C (lower thanthe critical temperature) and at a pressure of 10.5 bars.

Note2: The cold oxygen gas is warmed once outside the vessel in a coil of copper tubing. The increase in temperature causes an increase in pressure.

Note3: At a temperature of 15°C and atmospheric pressure, liquid oxygen can give 842 times its volume as gas.

Note4: The tank is well-insulated, a small amount of heat will be continuously absorbed from the surroundings, causing the liquefied gas to evaporate. This will slowly increase the pressure in the container which will open the safety relief valve venting O2 to atmosphere. Therefore, if a liquid system is left standing unused for a long period of time, a significant amount of O2 will be lost. Using liquid containers is economical only when there is a fairly constant demand. Having the proper size container will minimize O2 loss from venting.

OXYGEN CONCENTRATORS:

Oxygen concentrators, also known as pressure swing adsorption systems, extract oxygen from air by differential adsorption. These devices may be small, designed to supply oxygen to a single patient, supply oxygen to an anaesthetic machine OR they can be large enough to supply oxygen for a medical gas pipeline system.

Important note about O2 concentrator:

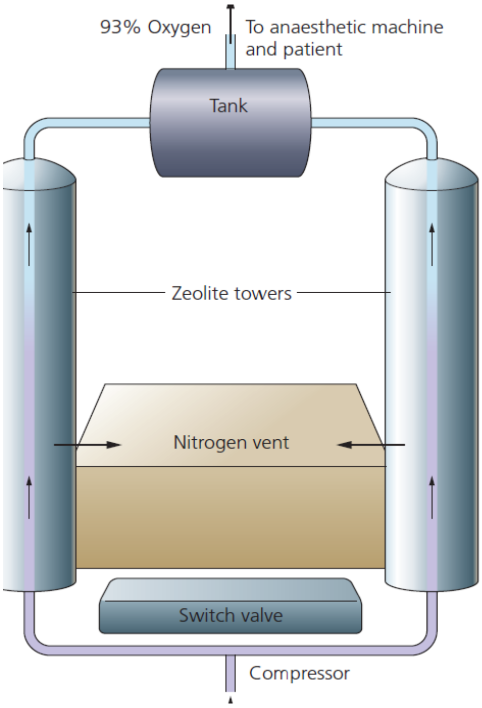
Note1: Ambient air is filtered and pressurized to about 137 kPa by a compressor.

Notee2: Air is exposed to a zeolite molecular sieve column, (**Zeolites are hydrated aluminium silicates of the alkaline earth metals in a powder or granular form)**forming a very large surface area, at a certain pressure.

Note3: The sieve selectively retains nitrogen and other unwanted components of air. These are released into the atmosphere after heating the column and applying a vacuum.

Note4: The maximum oxygen concentration achieved is 95% by volume. Argon is the main remaining constituent.

Note5: The life of the zeolite crystal can be expected to be at least 20 000 hours (which is about 10 years of use). Routine maintenance consists of changing filters atregular intervals.



Compressed air:

Medical air is supplied in a hospital for clinical uses or to drive power tools. The former is supplied at a pressure of 400 kPa and the latter at 700 kPa. The anaesthetic machines and most intensive care ventilator blenders accept a 400 kPa supply. The terminal outlets for the two pressures are different to prevent misconnection. Air may be supplied from cylinder manifolds, or more economically from a compressor plant with duty and back-up compressors. Oil-free medical air is cleaned by filters and separators and then dried before use.

Centralized vacuum or suction system:

Components

1. A pump or a power source that is capable of continuously generating a negative pressure of500- mmHg.

2. A suction controller with a filter.

3. A receiver or a collection vessel.

4. A suction tubing and suctionnozzle (e.g. a Yankaeur sucker) or catheter.

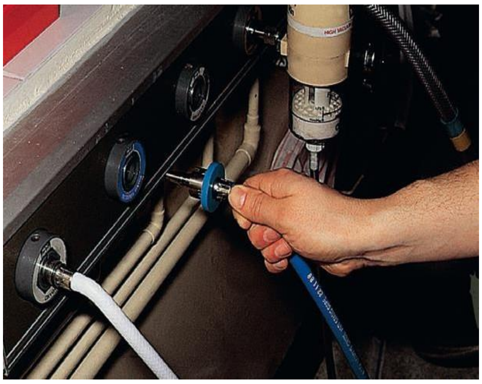
Important notes about vacuum or section system:

Note1: Negative pressure is generated by an electric motor and pneumatic-driven pumps using the Venturi principle.

Note2: The amount of vacuum generated can be manually adjusted by the suction controller.

Pipeline:

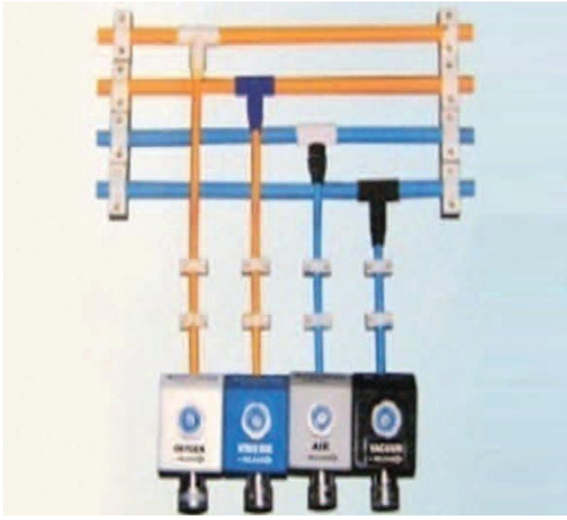
Pipework made of special high-quality copper alloy, which both prevents degradation of the gases it contains and has bacteriostatic properties. The fittings used are made from brass and are brazed rather than soldered.

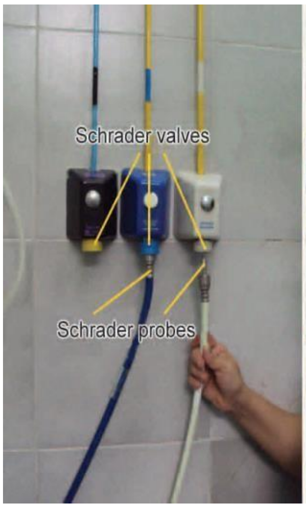


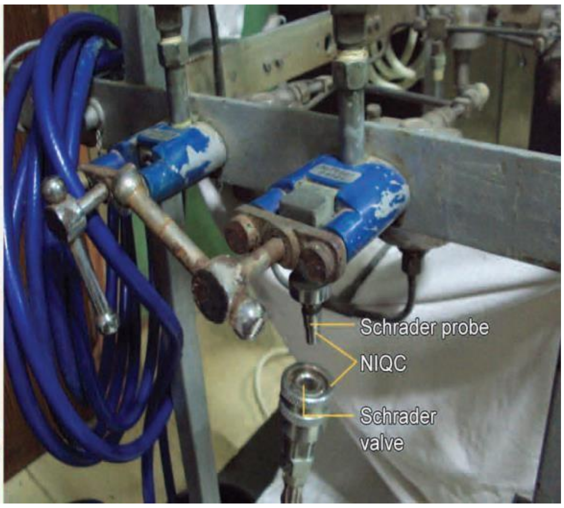
The size of the pipes differs according to the demand that they carry. Pipes with a 42 mm diameter are usually used for leaving the manifold. Smaller diameter tubes, such as 15 mm, are used after repeated branching.

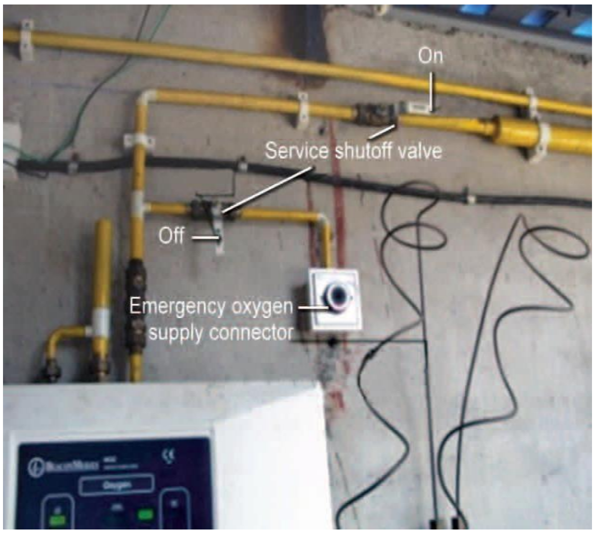
Outlets are identified by gas colour coding, gas name and by shape. They accept matching quick connect/ disconnect probes, with an indexing collar specific for each gas (or gas mixture).

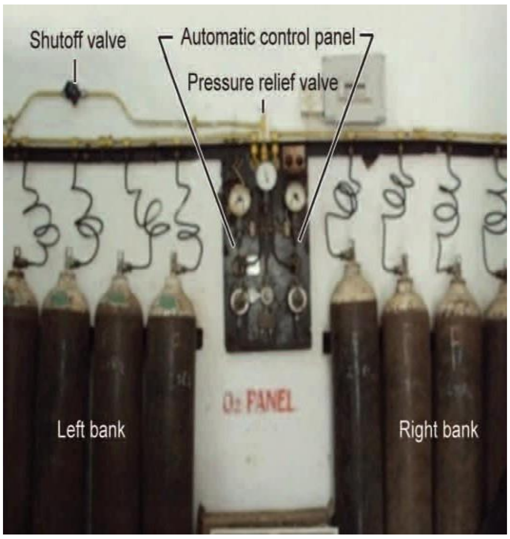
Flexible colour-coded hoses connect the outlets to the anaesthetic machine. The anaesthetic machine end should be permanently fixed using a nut and liner union where the thread is gas specific and non-interchangeable (noninterchangeable screw thread, **NIST**, is the British.

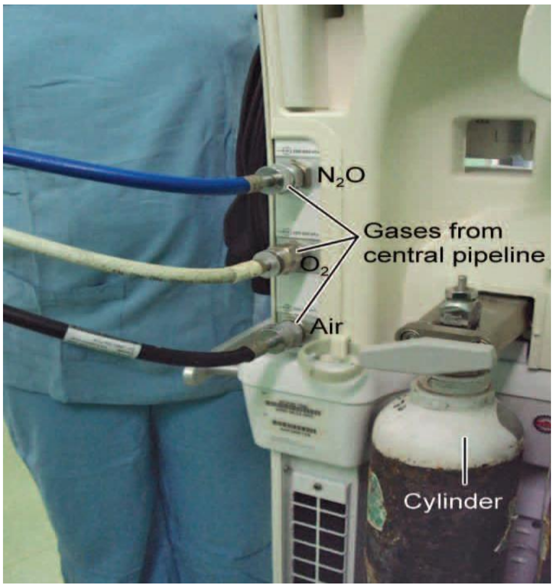


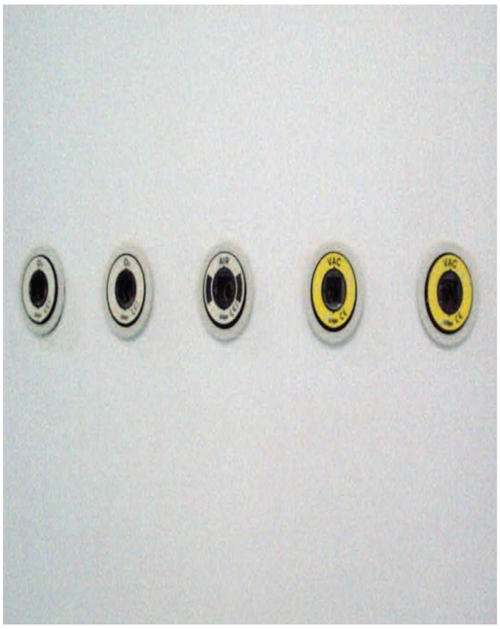

Schrader valves
Schrader probes


Schrader probe
NIQC
Schrader
valve


On
Service shutoff valve
Off
Emergency oxygen
supply connector

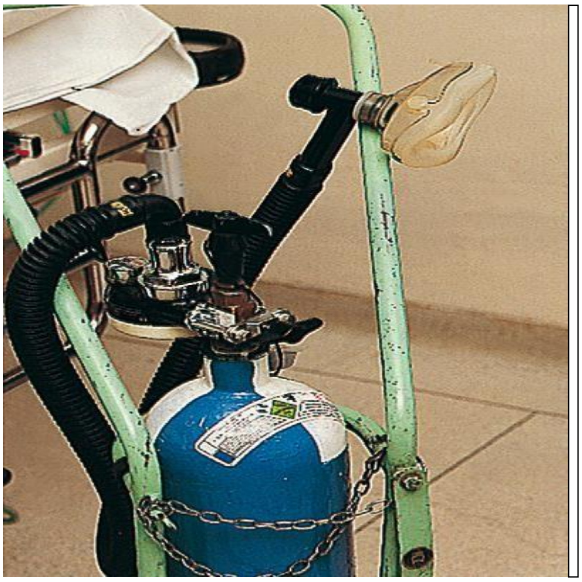

Shutoff valve
Automatic control panel
Pressure relief valve
O2 PANEL
Left bank
Right bank


N_2O
Gases from
central pipeline
O_2
Air
Cylinder



Entonox:

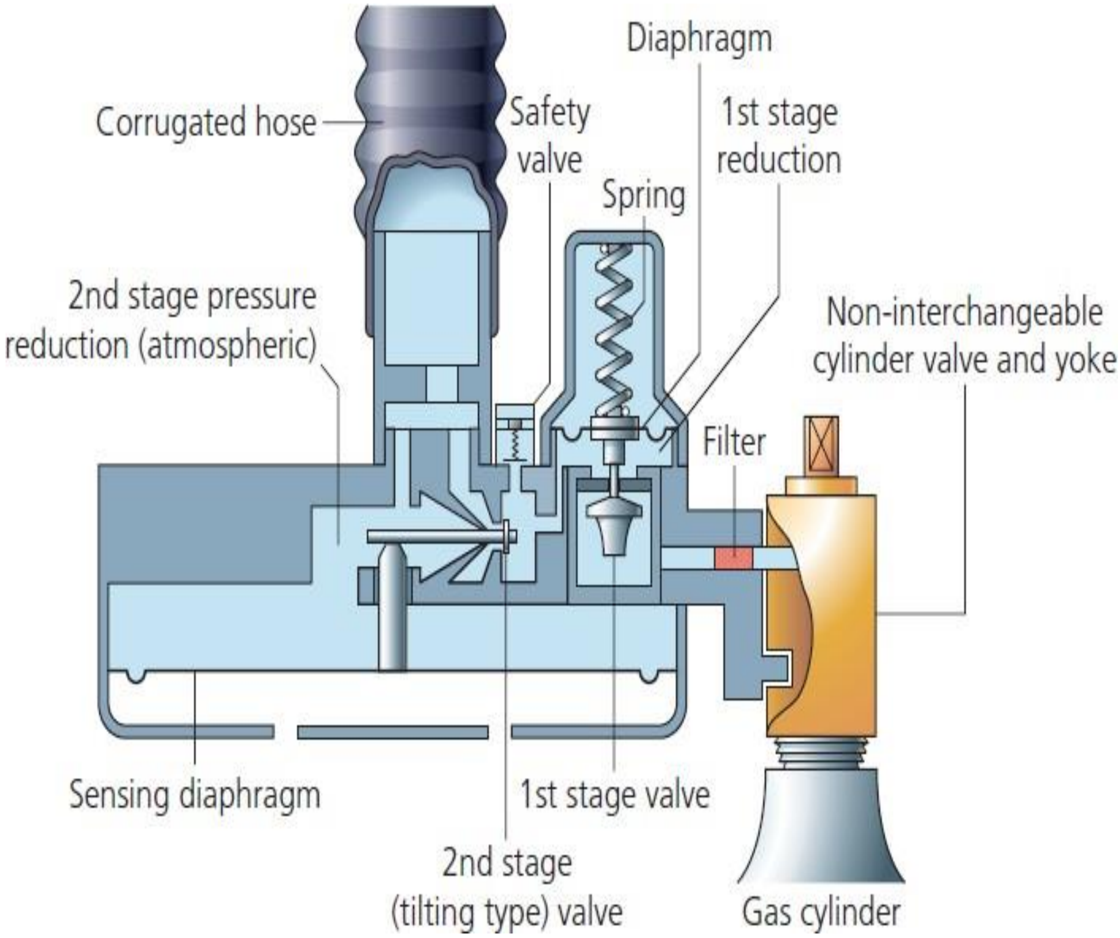
This is a compressed gas mixture containing 50% oxygen and 50% nitrous oxide by volume. It is commonly used in the casualty and labour ward settings to provide analgesia. A two-stage pressure demand regulator is attached to the Entonox cylinder when in use. As the patient inspires through the mask or mouth piece, gas flow is allowed to occur. Gas flow ceases at the end of an inspiratory effort.



Entonox is compressed into cylinders to a pressure of 13 700 kPa. Entonox cylinders should be stored at 10°C for 24 hours before use. If the temperature of the Entonox cylinder is decreased to below°5.5- C, liquefaction and separation of the two components occur (Poynting effect). **This results in:**

1. A liquid mixture containing mostly nitrous oxide with about 20% oxygen dissolved in it.
2. Above the liquid, a gas mixture of high oxygen concentration.

This means that when used at a constant flow rate, a gas with a high concentration of oxygen is supplied first. This is followed by a gas of decreasing oxygen concentration as the liquid evaporates. This may lead to the supply of hypoxic mixtures, with less than 20% oxygen, as the cylinder is nearly empty.


Diaphragm
Corrugated hose
Safety valve
1st stage reduction
Spring
2nd stage pressure reduction (atmospheric)
Non-interchangeable cylinder valve and yoke
Filter
Sensing diaphragm
1st stage valve
2nd stage (tilting type) valve
Gas cylinder

THANK YOU