



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Natural gas: origin, composition, properties

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Origin of natural gas

- ❖ Natural gas is **nonrenewable** fossil fuel;
- ❖ Natural gas was formed from the remains of tiny sea animals and plants that died 200-400 million years ago;
- ❖ Natural gas **exists in nature** under pressure **in rock reservoirs** in the Earth's crust, either dissolved in heavier hydrocarbons and water;
- ❖ It is produced from the reservoir similarly to or in conjunction with crude oil.



Origin of natural gas

Natural gas comes primarily from any one of three **types of gas wells**:

- ❖ *crude oil wells,*
- ❖ *gas wells,*
- ❖ *condensate wells.*



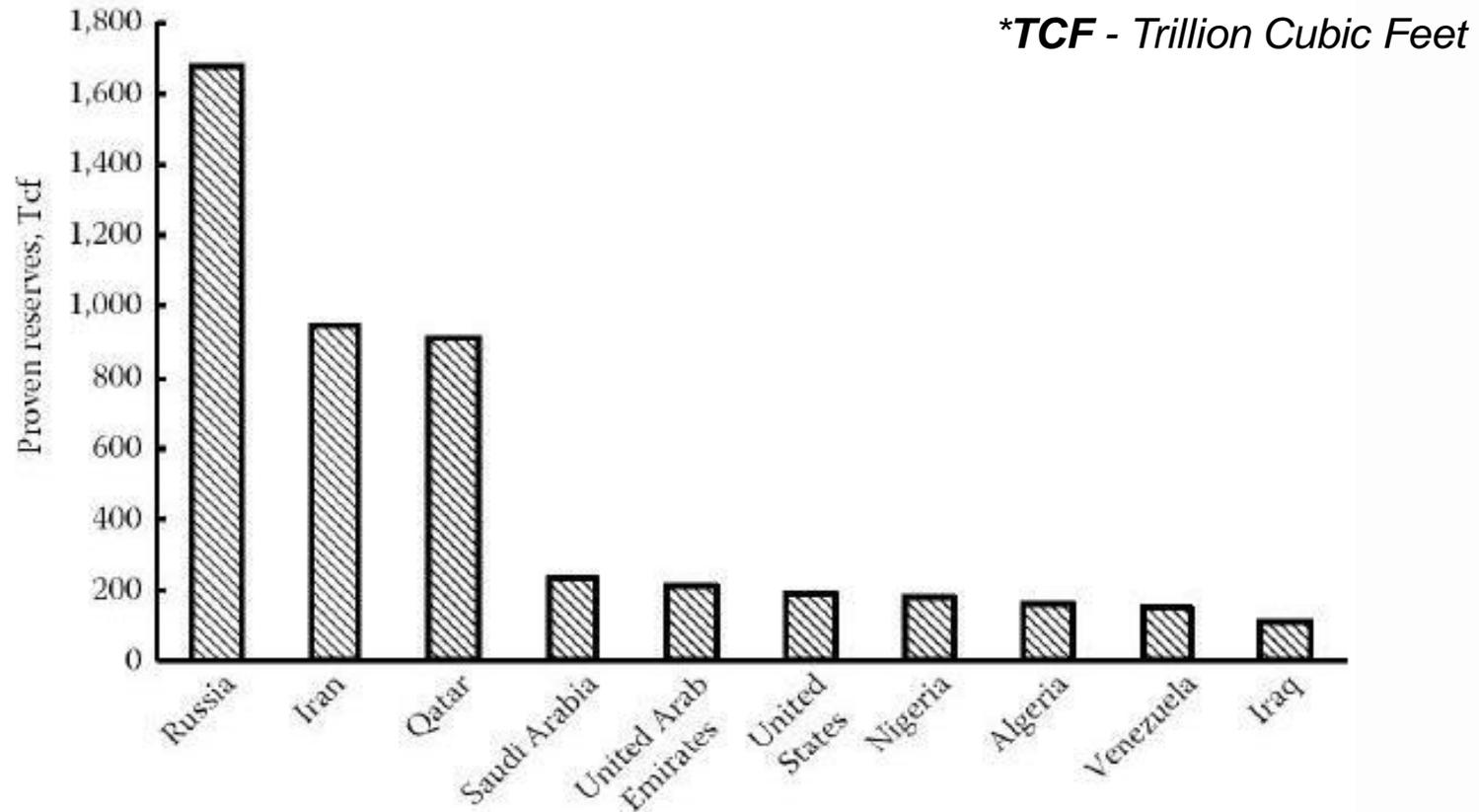
The varieties of **gas compositions** can be **categorized into three groups**:

- ❖ *Nonassociated gas* that occurs in conventional gas fields;
- ❖ *Associated gas* that occurs in conventional oil fields;
- ❖ *Continuous (or unconventional) gas.*

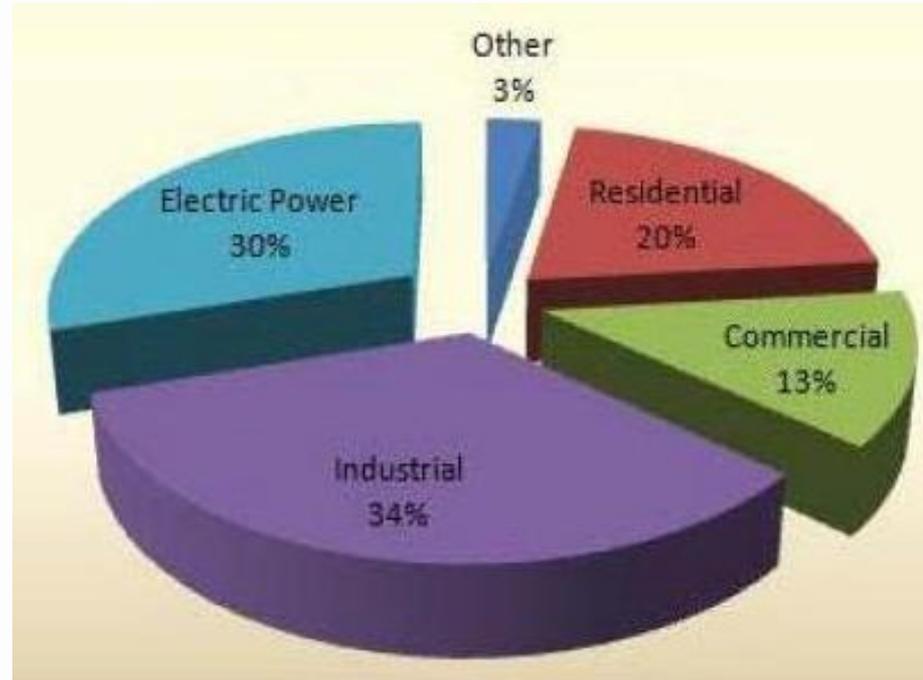




World natural gas reserves



Natural gas Uses



- ❖ power generation
- ❖ hydrogen production
- ❖ vehicles
- ❖ residential domestic use
- ❖ fertilizer
- ❖ aviation
- ❖ in the manufacture of fabrics, glass, steel, plastics, paint, and other products.

Composition of natural gas

Natural gas is a complex mixture of **hydrocarbon** and **non-hydrocarbon** compounds and exists as a gas under atmospheric conditions.

Natural gas typically consists primarily of **methane (CH₄)**.



Natural gas also contains varying amounts of:

- ❖ **Heavier gaseous hydrocarbons:** ethane (**C₂H₆**), propane (**C₃H₈**), normal butane (**n-C₄H₁₀**), iso-butane (**i-C₄H₁₀**), pentanes and even higher molecular weight hydrocarbons.
- ❖ **Acid gases:** carbon dioxide (**CO₂**), hydrogen sulfide (**H₂S**) and mercaptans such as methanethiol (**CH₃SH**) and ethanethiol (**C₂H₅SH**).
- ❖ **Other gases:** nitrogen (**N₂**) and helium (**He**).
- ❖ **Water:** water vapor and liquid water.
- ❖ **Liquid hydrocarbons:** perhaps some natural gas condensate and/or crude oil.
- ❖ **Mercury:** very small amounts of mercury primarily in elementary form, but chlorides and other species are possibly present.

Composition of natural gas

Name	Formula	Volume (%)
Methane	CH ₄	>85
Ethane	C ₂ H ₆	3-8
Propane	C ₃ H ₈	1-2
Butane	C ₄ H ₁₀	<1
Pentane	C ₅ H ₁₂	<1
Carbon dioxide	CO ₂	1-2
Hydrogen sulfide	H ₂ S	<1
Nitrogen	N ₂	1-5
Helium	He	<0,5

- ❖ **“dry”** gas when it is almost pure methane
- ❖ when other hydrocarbons are present, the natural gas is **“wet”**





Effect of impurities found in natural gas

Water vapor	H ₂ S and CO ₂	Liquid hydrocarbons
<p>It is a common impurity.</p> <p>a) Liquid water accelerates corrosion in the presence of H₂S gas.</p> <p>b) Solid hydrates block plug valves and fittings in pipelines.</p>	<p>Both gases are harmful, especially H₂S, which is toxic if burned.</p> <p>It gives SO₂ and SO₃ which are nuisance to consumers.</p> <p>a) Both gases are corrosive in the presence of water.</p> <p>b) CO₂ contributes a lower heating value to the gas.</p>	<p>Their presence is undesirable in the gas used as a fuel.</p> <p>a) The liquid form is objectionable for burners designed for gas fuels.</p> <p>b) For pipelines, it is a serious problem to handle two-phase flow: liquid and gas.</p>



Chemical and physical properties of natural gas

- ❖ Natural gas is *colorless, odorless, tasteless, shapeless*, and *lighter than air*.

Properties	Value
Molar mass	17–20
Carbon content, weight %	73,3
Hydrogen content, weight %	23,9
Oxygen content, weight %	0,4
Hydrogen/carbon atomic ratio	3,4–4,0
Density, 15 °C	0,72–0,81
Boiling point, °C	-162
Autoignition temperature, °C	540–560
Octane number	120–130
Methane number	69–99
Vapour flammability limits, volume %	5–15
Flammability limits	0,7–2,1
Lower heating/caloric value, MJ/kg	38–50

