

The Wobbe Index and Natural Gas Interchangeability

What Is The Wobbe Index And Why Is It Important To Natural Gas Systems?

Natural gas interchangeability is a key subject in the industry today, and a work group in the American Gas Association has been addressing it. This is a customer-focused effort. The industry is making sure that the quality of the natural gas that arrives at appliances, boilers, burners, power plants, turbines—anything that uses natural gas—meets users' needs. Emissions and equipment maintenance are major issues but the ultimate measure continues to be the BTU content.

The substantial increase in sources of gas is the primary driver. In North America, today's extensive pipeline network means that natural gas arriving at your burner could come from practically anywhere on the continent. Compositions vary from one source to another. Local distribution companies (LDCs) further contend that the processing of gas also varies.

Most recently, Liquid natural gas (LNG) has emerged as a major source and the industry knows that the composition of gas derived from LNG differs substantially from domestically-produced gas.

Operations of peak-shaving and LNG plants are also under review as new users come on-line because some of the new equipment is very sensitive to gas quality.

So, the gas company needs to make sure the BTU per cubic foot is correct, right?

Well...not quite. You really have to get the Wobbe Index, sometimes call the Wobbe Number, correct. It's an old concept but...it's back.

What Is The Wobbe Index?

The Wobbe Index is actually the correct representation of the heating value of natural gas arriving, from the gas line, at the orifice where a burner is located.

It is not simply the BTU per cubic foot but rather the BTU per cubic foot divided by the square root of the specific gravity:

$$\text{Wobbe Index} = \text{BTU/cubic foot} / \sqrt{\text{SG}}$$

In 1927, Goffredo Wobbe, a physicist in Bologna, Italy, observed that:¹

- The heat output of a burner is proportional to the flow volume per time (given constant pressure and constant orifice size)
- The flow velocity through a given orifice size at constant pressure is proportional to the specific gravity of the gas
- The calorific value, or heating value, of a gas is proportional to its specific gravity.

An explanation of the Wobbe Index from AGA Bulletin No. 36 is as follows:²

"The Wobbe number, or Wobbe index, of a fuel gas is found by dividing the high heating value of the gas in Btu per standard cubic foot by the square root of its specific gravity with respect to air. The higher a gases' Wobbe number, the greater the heating value of the quantity of gas that will flow through a hole of a given size in a given amount of time. It is customary to give a Wobbe number without units—even though it has the dimensions Btu per scf—because to do so would lead to confusion with the volumetric heating value of the gas.

“In almost all gas appliances, the flow of gas is regulated by making it pass through a hole or orifice. The usefulness of the Wobbe number is that for any given orifice, all gas mixtures that have the same Wobbe number will deliver the same amount of heat. Pure methane has a Wobbe number of 1363; natural gas as piped to homes in the United States typically has a Wobbe number between 1310 and 1390.”

Equipment is rated to operate over a specified Wobbe Index range and, in some cases, provides an adjustment that corresponds to the Wobbe Index.

A Few Examples

The Wobbe Index of a gas with a specific gravity is 0.6 and a BTU/cubic foot heating value of 1000 is as follows:

$$\text{Wobbe Index} = 1000 / \sqrt{0.6} = 1291$$

A gas with a specific gravity of 0.6 and a BTU/cubic foot of 1050 is well within the typical range mentioned in the AGA bulletin:

$$\text{Wobbe Index} = 1050 / \sqrt{0.6} = 1356$$

In fact, for pure Methane and the next two, “heavier” hydrocarbons, Ethane and Propane, properties are as follows:

	<u>BTU/Cubic Foot</u>	<u>SG</u>	<u>Wobbe Index</u>
Methane	1012	0.55	1365
Ethane	1773	1.04	1739
Propane	2522	1.52	2046

Ethane content is important because LNG tends to contain much more ethane than domestic natural gas sources. Wobbe numbers for mixtures containing Ethane can be well above 1400, which could be beyond the ratings of some gas-operated equipment. Gas companies must make sure the LNG-derived gas is mixed with other sources in order to reduce the Wobbe Index. Otherwise, expensive processing may need to be introduced to make an adjustment.

A peak-shaving plant is a very good example for which engineers need to consider the properties of Propane. When entered into the mix, Propane introduces a much higher Wobbe Index and must be significantly ratioed-down.

RTU and Flow Computer Applications

Since the BTU/cubic foot heating value and the specific gravity are normally available in flow computer applications, it is easy for a programmer to add a calculation for the Wobbe Index.

You can use the BTU/standard cubic foot, which comes from a chromatograph or AGA5 and simply divide it by the square root of the specific gravity.

References:

1. “Automatic Wobbe Index Control for Peak Shaving Plants,” 2004 LP Symposium, W. H. Driftmeier
2. American Gas Association, Bulletin No. 36

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