Methane (CH₄) is the second largest source of greenhouse gas emitted in the U.S. In 2013, CH₄ accounted for about 10 percent of all U.S. greenhouse gas emissions from human activities. Methane's half-life in the atmosphere is much shorter than that of carbon dioxide (CO₂); however, it is significantly more efficient at trapping radiation. Pound for pound, the comparative impact of CH₄ on climate change is 25 times greater than that of CO₂ during a 100-year period.

One area responsible for contributing to the increase in CH₄ is leaking equipment in the oil and gas sector. A major contributor to this leakage is valves that leak CH₄ and sub-derivatives called volatile organic compounds (VOC) from the gland.

During the last 30 years, governmental agencies have worked with industry leaders to address these leaks by increasing the implementation of new technology. This focus has prompted packing manufacturers to ramp up research and development of new materials. State and federal agencies have also tightened standards for maximum leak rate measurements of VOC values from 10,000 parts per million (ppm) 20 years ago to 100 ppm in most places in the U.S. today. As a comparison, that is like changing the Corporate Average Fuel Economy (CAFE) limits for miles per gallon (mpg) of automobiles from 1990 levels of 27.5 to 2,750 mpg.

One of the main challenges the industry needed to overcome was the lack of a unified testing standard. Twenty-five years ago, many refineries and packing manufacturers used their own testing standards with varying...
media (nitrogen, helium or methane at different concentrations),
temperature ranges and thermal cycles. These variations made it
difficult to compare the effectiveness of valve emission packing. A few
standard organizations created tests for valve emissions addressing
this issue.

The American Petroleum Institute (API) was one
organization that specifically
focused on a detailed testing
procedure for packing performance
in methane. The standard, API
622, has become a benchmark for
packing performance in the U.S.
for a variety of reasons, including
the Environmental Protection
Agency’s (EPA) insistence that
packing performance testing be
conducted using methane instead
of other gases. This standard
became the catalyst for research
and development efforts to create
valve packing that could meet a less
than 100 ppm requirement.

Using methane as a test gas, API
622 requires five thermal cycles
from ambient temperature to
260 degrees C (500 F) with 1,510
mechanical cycles. Thermal cycles
are completed once per day and
are divided into 300 mechanical
cycles (150 at ambient and 150
at 260 C). A final 10 mechanical
cycles are completed at ambient
temperature, where the final
leakage measurement is taken.
This test requires a large number
of mechanical and thermal cycles
and is designed to challenge
packing manufacturers to improve
development.

At the 2015 ISA Leak Detection
and Repair (LDAR) Symposium,
a paper by Buzz Harris from Sage
Environmental focused on emission
factors of leakage in refineries. His
main focus was comparing testing
data from API 622 to current
common limits. He concluded
that, in refining gas and vapor
service, the emission factor would
be reduced from 2.6 x 10^-2 to 1.0 x
10^-5 kg/hour/source—a decrease of
more than a 1,000 times.

One important point is that
API 622 is not a valve test but a
packing test. It would be a mistake
to assume that all valves will
exhibit the same performance
with the same packing. This is
because all valves have their own
unique design characteristics that
affect overall sealing, primarily
tolerances and unique valve
design features. As a result, API
created a testing protocol—API
624—that focused on emissions
capability by valve design and valve
manufacturer (see Image 1).

One other significant standard
to note for valve testing is
International Organization for
Standardization (ISO) 15848.
Originally specifying helium
as a test gas and mass flow rate
as a measuring protocol, the
standard was modified earlier
this year to include testing with
methane gas using a concentration
measuring method.

API standards often complement
each other and build on previous
work. In the case of API 624, one
of the prerequisites is that the
packing used has already been
tested to the API 622 standard.
This is one reason the API 624
has fewer thermal cycles and
stem actuations than API 622
(the 624 test procedure requires
310 mechanical cycles and three
thermal cycles to 260 C [500 F]).

API has also published design
standards for other types of
valves (API 600 and 602, for
example). These standards are
living documents that, as they are
reviewed, will also reference the
API 622 and API 624 standards
for low-emission valves. This
is significant in helping the
petroleum industry reduce overall
methane emissions.

Some of the lessons learned
from API 624 have focused on
the machining tolerances of
components. Methane molecules
are relatively small and leak rapidly

![Image 1. Valve design considerations](image-url)
through small gaps compared with steam and other media. This means that users should not use standard gland and valve dimensioning for steam service in emissions applications. The main areas of concern are stem and box size tolerance, the packing gland clearance to the stuffing box and stem, and the stem to the inside diameter of the bottom of the stuffing box clearance. All of these dimensions are critical to successful emissions sealing (see Figure 1).

Another often overlooked area of concern that is critical for sealing methane is the bolting on the valve gland. One of the most important issues that testing confirmed is that the condition of the bolts can have a significant effect on the accuracy of the gland load on the packing. Lubrication is critical, and new bolts (as compared with used bolts) can drastically affect how the valve seals operate. Depending on the condition of the bolts, a user may not be getting the correct gland load. This is because, in most cases, the applied gland load is only assessed by torque, a measurement not of tension but of force over the threads and nut. When using unlubricated used bolts compared with new bolts, the same torque will result in a much lower tension and an under-loaded gland. One way to mitigate this problem is to use a load indicator, such as disc springs height, which measures specific tension on the connection.

The work the petroleum industry, regulatory agencies, packing manufacturers and the valve industry have completed has served to reduce methane emissions. New packing materials and formulations, new testing standards and valve design improvements have allowed the industry to lower their environmental footprint by minimizing emissions.

**Next Month:** Insulating Over Rubber Expansion Joints: A Good or Bad Idea?

We invite your suggestions for article topics as well as questions on sealing issues so we can better respond to the needs of the industry. Please direct your suggestions and questions to sealingsensequestions@fluidsealing.com.