TESCORP "ERU" (Emissions Recovery Unit)

Problem Summary - Mitigating methane emissions from compressor packing

In a recent EPA study released in the Natural Gas STAR Program, "Estimates of Methane Emissions by Segment in the United States" the following information was stated concerning methane leakage into the environment:

- Methane emissions account for 9.5% of all greenhouse gases. These emissions when based upon CO2, have a comparative effect on the environment that is 25 times that of equivalent CO2.
- The energy industry is the 2nd largest source of methane emissions.
- A 2018 study of these gas emissions as reported by the EPA, estimated these methane emissions total approximately **175 MMTCO2e** per year to the environment.
  - Of that total, 19% was emitted from the Transmission and Storage facilities within the oil and gas industry.
  - That equates to an emission source of approximately 34 MMTCO2e.
    The breakdown of those emission leaks is:
    - 0.68 MMTCO2e from gas operated Pneumatic Controllers.
    - 15.0 MMTCO2e from gas compression equipment seal & packing leaks.
      - ✓ 3.1 MMTCO2e from Centrifugal Compressors.
      - ✓ 11.9 MMTCO2e from Reciprocating Compressors.
  - Additionally, the same report indicated that the Gas Processing Industry accounted for an additional 12 MMTCO2e of emissions per year to the atmosphere. A similar breakdown of the leaks can also be attributed to:
    - 0.68 MMTCO2e from gas operated Pneumatic Controllers.
    - 15.0 MMTCO2e from gas compression equipment.
      - ✓ 1.0 MMTCO2e from Centrifugal Compressors.
      - ✓ 1.56 MMTCO2e from Reciprocating Compressors.

Source*: Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2018, US EPA, April 2020*

Leakage from compressor rod packing

Most of these emission sources can be captured and restored back to the process without emitting them to the environment.

Without considering the emissions with the other previously stated sources, the compressor rod packing leakage will be used as the example problem and a reasonable solution discussed.

Description of gas emissions source

- Reciprocating compressors in the oil and gas industry commonly emit natural gas (where methane is the main component) during normal operation and during standby under pressure. These emissions can be vented from the rod packing and blowdowns or as fugitives from the various compressor components.

Reducing methane emissions from compressor rod packing systems

- More than 51,000 reciprocating compressors are operating in the U.S. natural gas industry, each with an average of four cylinders, representing over 200,000 piston rod packing systems in service. Reciprocating compressors normally have multiple cylinders, and each cylinder piston rod has a packing case. Reciprocating compressor maintenance practices may vary and rod packing vents may be configured. These systems contribute over:
- 72.4 Bcf per year of methane emissions to the atmosphere, one of the largest sources of emissions at natural gas compressor stations.
- All packing systems leak under normal conditions, the amount of which depends on cylinder pressure, fitting and alignment of the packing parts, and amount of wear on the rings and rod shaft.
- Under the best conditions, even new packing systems properly installed on a smooth, well-aligned shaft can be expected to leak a minimum of 11.5 scfh. Higher leak rates are a consequence of fit, alignment of the packing parts, and wear.
- As the system ages, however, leak rates will increase from wear on the packing rings and piston rod. One Natural Gas STAR Partner reported measuring emissions of 900 scfh on one compressor rod.

Exhibit 1: Typical Compressor Rod Packing System

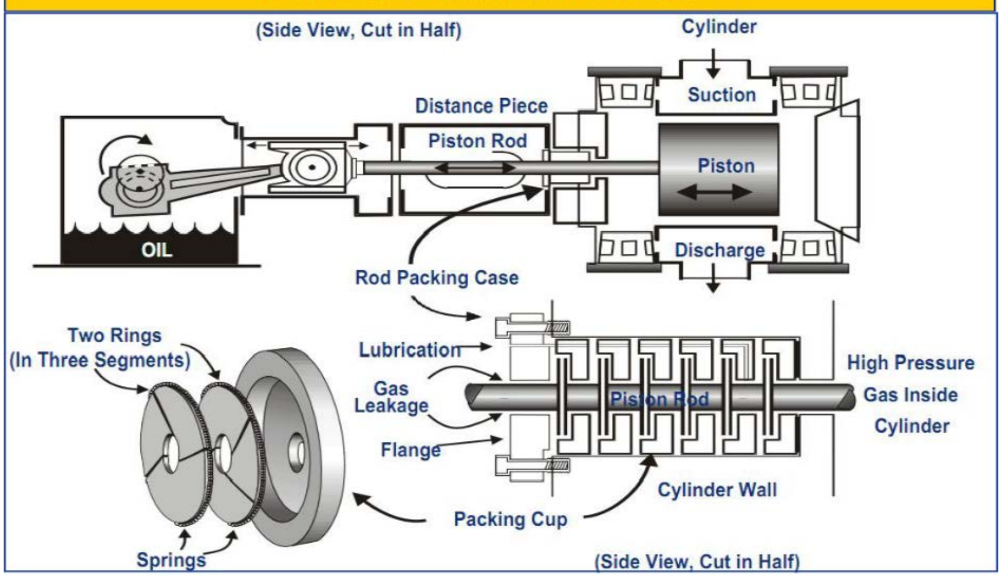


Illustration presents a typical compressor rod packing system.

- **Leakage typically occurs from four areas:**
  - Around the packing case through the nose gasket.
  - Between the packing cups, which are typically mounted metal-to-metal against each other.
  - Around the rings from slight movement in the cup groove as the rod moves back and forth.
  - Between the rings and piston rod.

Source: From existing Climate & Clean Air Coalition published documents.
CCAC OGMP – Technical Guidance Document Number 4: Reciprocating Compressors Modified: April 2017

Emission Factors

Table 4.2: Default Emission Factors for Reciprocating Compressor Rod Packing [A,B,C]

Industry Sector	Methane Emission Factor	
	Methane Emission Factor (scm/hour-compressor)	Methane Emission Factor (scf/hour-compressor)
Production (Well Pads)[17]	0.031	1.08
Gathering & Boosting[18]	2.4	85.5
Processing[19]	4.03	142.5
Transmission[20]	5.3	188.1
Storage[21]	6.5	229.5

[A] These compressor-based operating emission factors assume an average number of cylinders per compressor as follows: Production (4), Gathering and Boosting (3.3), Processing (2.5), Transmission (3.3), and Storage (4.5).
[B] Methane content by sector: Production (79 percent); Processing (87 percent); Transmission, Storage, and Distribution (94 percent). (Source: EPA. Natural Gas STAR Lessons Learned. https://www.epa.gov/sites/production/files/2016-06/documents/ll_rodpack.pdf.)
[C] A factor of 150% should be applied to default operating emission factors for standby under pressure factors. https://www.epa.gov/sites/production/files/2016-06/documents/ll_compressorsoffline.pdf .|

- Lubricating oil injected into the packing helps seal the rings and cups, reduces wear caused by operation, and lowers heat build-up that accelerates ring wear. But over the thousands of hours of typical compressor operation, rings wear and leakage increases. Average leakage of large, high-pressure reciprocating compressors ranges from 24 to 150 scfh.
- Factors other than normal wear can also contribute to emissions, such as faulty installation and damaged components (cups, rings, gaskets).

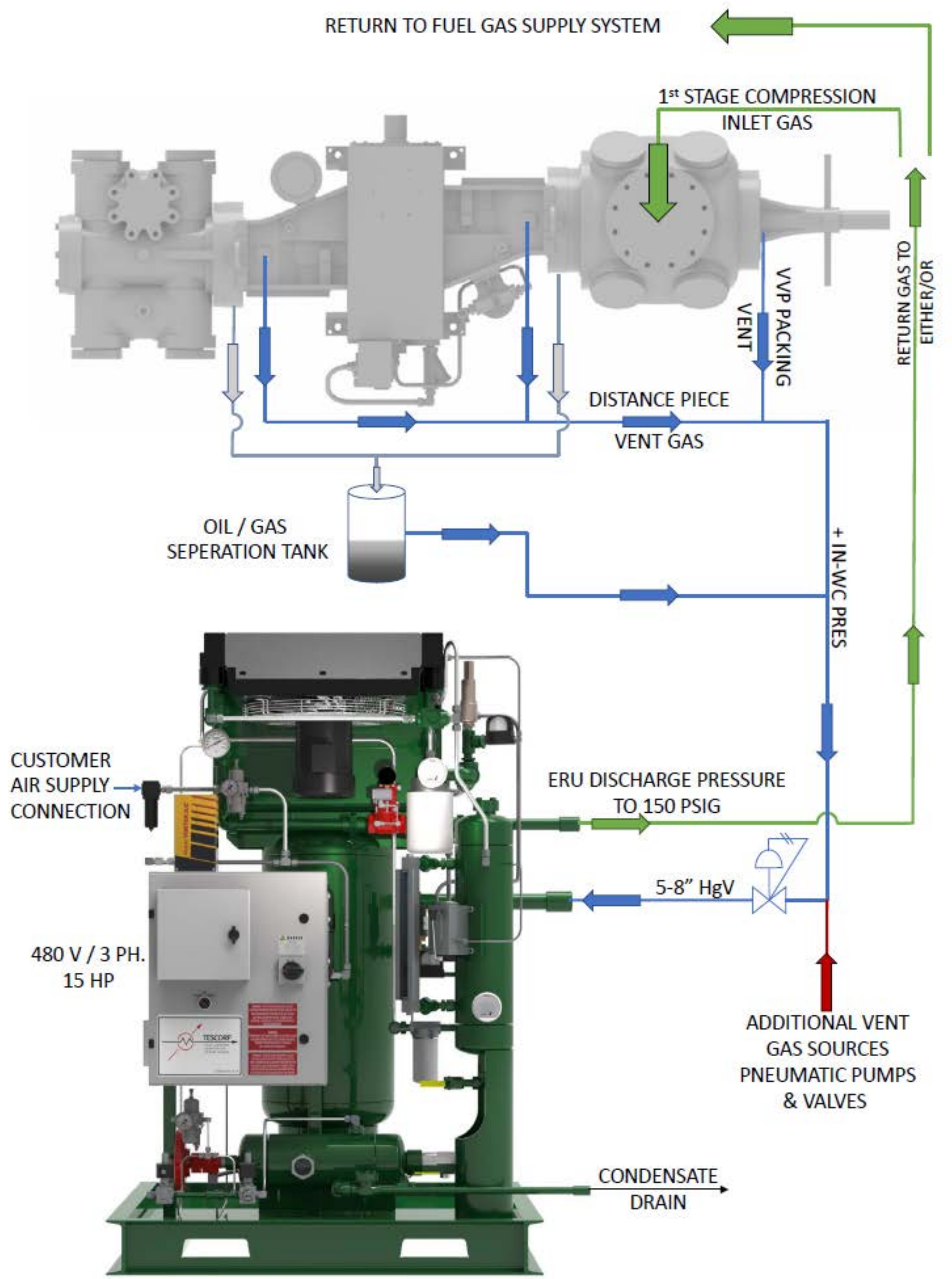
The Problem Summation

- All compressor packing assemblies leak.
- Even with new packing installed, there is a continuous source of leakage to the atmosphere.
- With even the reduced levels of leakage acquired with new and more sophisticated packing, there is still a significant amount of leakage.
- Assuming the minimum amount of leakage with new packing @ 11 to 12 scfh per piston rod packing assembly X 200,000 piston rod packing assemblies that are estimated to exist in the United States, <u>the new projected minimum is in the range of 20+ Bcf per year.</u>

***These gas emissions can be recovered and reentered back into the gas process system.

TESCORP ERU (Emissions Recovery Unit)

The Tescorp "VentMaster ERU" captures and returns the vent gases back to the process.



TESCORP "ERU" (Emissions Recovery Unit)

TESCORP

UNIQUE PACKING EMISSION SOLUTION

ERU-1250

Encapsulated scroll compressor
15 Horsepower system
Capacities of 1250 SCFH
Discharge pressures to 150 Psig

Eliminate costly fugitive emissions and service expenses & stay in compliance with EPA mandates with our proprietary methane solution.

This unit addresses the issue of leaking piston rod packing systems by:

1. Recovering the gas from the compressor packing box by utilizing a back-pressure regulator to maintain a positive pressure in the packing case. The vapors are then evacuated by the TESCORP ERU that produces a slight vacuum as necessary to capture and transport all leaking emissions.
2. The recovered gas is then pressurized to meet the existing pressures necessary to re-enter either the first stage of compression or the compressor fuel gas system for utilization in the current process.
3. The TESCORP "ERU" system is capable of capacities of 1250 scfh and discharge pressures of up to 150 psig.

Proud Member
Global Methane Initiative
Project Network

Designed and constructed as a complete system for ease of installation and operation, systems are complete with:

- Encapsulated 15 horsepower compressor unit without packing or seals to leak
- 3-Phase/460VAC VFD with controller for totally automatic operation and capacity control
- NEC Class I, Division II controls with customer interface and local fault annunciation
- Vacuum receiver with condensate blow-case for removal and elimination of produced condensates
- Compact design with only a 4' x 4' footprint for ease of installation & utilization of space
- Gas after-cooling of discharge gas for reinjection into either 1st stage of compression or into the compressor fuel gas system
- Weather-proof enclosure available as option

Economic and environmental aspects:

- All compressor packing assemblies leak and the gas emissions are both costly in terms of product lost and regulatory issues and fines.
- The cost of the required unit downtime and service required to replace the compressor packing are substantial costly budget items.

The TESCORP "VentMaster ERU" captures these emissions and returns them back to the process without any venting to the environment. Utilizing the ERU (emission recovery unit) does allow the operators to defer packing change out with much longer periods of operation thus reducing both maintenance and downtime costs.

TO CONTACT US: SALES@TESCORP.COM; WWW.TESCORP.COM