

Using the Greenhouse Gas Reporting Program Data to Improve the National Greenhouse Gas Emissions Inventory for Petroleum and Natural Gas Systems

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ABSTRACT

The American Petroleum Institute (API) has been engaged for close to two decades in improving methodologies for estimating greenhouse gas (GHG) emissions from petroleum and natural gas industry operations. In 2010 the U.S. Environmental Protection Agency (EPA) promulgated a nationwide mandatory Greenhouse Gas Reporting Program (GHGRP) with detailed guidance for measurements and calculations of GHG emissions from 41 industry sectors. Petroleum and natural gas facilities emitting over 25,000 metric tons of CO₂-equivalent/year have reported their GHG emissions since 2011 under the provisions of Subpart W of the GHGRP. API has collaborated with the EPA by providing feedback throughout the years on both the reporting program and the national GHG emissions inventory (GHGI).

This paper describes the wide ranging efforts undertaken by the API to ensure the incorporation of robust GHGRP data into the GHGI. This paper will focus on improved assessment of the dynamic scope of activities - and corresponding emissions - from petroleum and natural gas production and natural gas processing operations. The approach to refine the GHGI will be addressed by comparing various sources, to properly document the scope of industry activities, as reflected by the national count of operating wellheads and natural gas processing plants. As a case in point, this paper will demonstrate how the GHGRP measurement data could be used to derive updated methane emission factors for compressors in the natural gas processing segment of the industry

INTRODUCTION

EPA publishes an annual U.S. national GHGI as part of the multilateral obligations specified by the United Nations Framework Convention on Climate Change. For the petroleum and natural gas sectors, much of the initial data in the GHGI came from studies conducted in the early to mid-1990's.¹ However, with mandatory GHG reporting for large facilities beginning in

2010, a significant amount of information is now available for GHG emission sources through the GHGRP. Petroleum and Natural Gas Systems facilities began reporting GHG emissions in 2011 using the calculation methodologies specified in 40 CFR 98.233 and the reporting requirements of 40 CFR 98.236.² API has analyzed the GHGRP data which is reported publically each year and used the results of the analysis to provide recommendations to EPA for updating the GHGI methodology.

The paper provides details for two areas in which API provided EPA with recommendations for improved methods for the national GHG Inventory:

- Comparison of different sources to refine the assessment of petroleum and natural gas well counts that are subsequently used for estimating industry activities;
- Demonstration of how the GHGRP measurement data could be used to derive updated methane emission factors for compressors in the natural gas processing segment of the industry.

These two examples are provided as an illustration of the extent of API's analysis of GHGRP reported activities and emissions data from other key industry sources, with primary emphasis on the petroleum and natural gas production and natural gas processing segments of the industry.

WELL COUNTS IN THE GHG INVENTORY

A number of Petroleum and Natural Gas emission sources in the GHGI rely on counts of producing wells as a key data input for emission calculations. For some sources well counts data are used directly as the activity data input (e.g., calculations for fugitive emissions from wells); for other sources well counts are used to estimate the population of related equipment in a given year (e.g., calculations for pneumatic devices which use the number of pneumatic devices per well and well counts); and still for others well counts are used to calculate other inputs (e.g., dehydrator vent calculations use well counts, number of dehydrators per well, and the amount of throughput per dehydrator).

Starting in 2013, EPA began using the U.S. well data provided by DrillingInfo to establish the national well count. However, API had noted significant differences in the well counts used by EPA compared to other data sources of national oil and gas well counts. Table 1 compares API's estimate of U.S. oil and gas wells using DrillingInfo to EPA's and other sources of national well counts for calendar year 2014.

Table 1. Comparison of 2014 and 2015 U.S. oil and gas well counts.

	EPA (HPDI, 2014)	API (HPDI, 2014)	IPAA³ (IHS, 2014)	World Oil⁴ (States, 2015)	EIA⁵ (HPDI, 2015)	DrillingInfo (HPDI, 2014)*
Non-Associated Gas Wells	456,140	436,846	514,782	502,987	578,000	426,658
Total Producing Oil Wells	898,268	550,994	600,679	594,436	470,000	601,963
Associated Gas Wells (subset of oil wells)	503,873	331,580				
TOTAL	1,354,408	987,840	1,115,461	1,097,423	1,048,000	1,028,621
Differential from EPA Total		-366,568	-238,947	-256,985	-306,408	-325,787

* These data represent a run of 2014 well counts that was performed by DrillingInfo for API

All of the sources reviewed have lower total well count estimates than EPA. API and EPA's estimate of non-associated gas well counts are comparable. The significant difference is in the oil well count. While we expect some differences due to how EPA and API are each able to access the DrillingInfo data, it is unlikely that this is the cause of the entire difference in well counts.

API presented this information and discussed well counts with EPA on several occasions. For the GHGI released in March 2017 for RY2015⁶, EPA updated their approach to incorporate a recent revision to the DrillingInfo dataset that clarified information for certain well records. In the previous DrillingInfo datasets, records for certain wells in Texas had been assigned multiple well identification numbers over time resulting in double counting of specific wells. The resulting well counts used in the GHGI are more comparable to those from other data sources.

GHGRP COMPRESSOR DATA FOR GAS PROCESSING FACILITIES

Natural gas processing facilities with total GHG emissions greater than 25,000 metric tons of CO₂ equivalent emissions have been reporting GHG emissions to EPA since 2011. A total of 467 gas processing facilities reported GHG emissions data through the GHGRP for reporting year 2015. The GHGRP provides substantial information, including compressor counts and measured compressor component emissions that can be used to update data for EPA's national GHGI.

Compressor Activity Data Updates

Compressor activity data from the GHGRP for RY2013 through RY2015 compared to the 2016 GHGI (RY2014)⁷ activity data are presented in Tables 2 and 3 for centrifugal and reciprocating compressors, respectively. Weighted average counts of compressors per gas plant are shown in the shaded cells.

Table 2. Comparison of centrifugal compressors activity data: 2016 GHGI (RY2014) and RY2013-RY2015 GHGRP.

	2016 GHGI RY2014	RY2015 GHGRP Data	RY2014 GHGRP Data	RY2013 GHGRP Data
# Gas plants nationally	668			
# Gas plants reporting to the GHGRP		467	464	437
# Dry Seal Centrifugal Compressors	306	214	186	183
# Dry seal compressors per gas plant	0.46	0.46	0.40	0.42
		<i>0.43</i>		
# Wet Seal Centrifugal Compressors	665	264	271	267
# Wet seal compressors per gas plant	1.0	0.57	0.58	0.61
		<i>0.59</i>		

Table 3. Comparison of reciprocating compressors activity data: 2016 GHGI (RY2014) and RY2013-RY2015 GHGRP.

	2016 GHGI RY2014	RY2015 GHGRP Data	RY2014 GHGRP Data	RY2013 GHGRP Data
# Gas plants nationally	668			
# Gas plants reporting to the GHGRP		467	464	437
Reciprocating Compressors	6,020	2,662	2,603	2,382
# Reciprocating compressors per gas plant	9.01	5.70	5.61	5.45
		5.59		

GHGRP data show that the number of dry seal centrifugal compressors and reciprocating compressors per gas plant have increased over the three years that they were reported, while wet seal centrifugal compressors per gas plant show a slight decreasing trend. For all years and compressor types, the GHGRP ratios of compressors to gas plant counts are lower than the GHGI ratios. EPA has revised the compressor counts in the most recent 2017 GHGI (RY2015)⁶ to utilize the counts of compressors per gas plant from the RY2015 GHGRP data.

GHGRP Data for Compressor Emission Factor Updates

The GHGRP mandates that specific compressor components should be measured for gas processing facilities. Measurements are conducted in the “as found mode”, meaning that the reporter does not have to measure all of the operating modes in a given year. Instead, components are measured based on the operational conditions of the compressor at the time of measurement. The components requiring measurement and the corresponding modes of operation are summarized in Table 4.

Table 4. GHGRP compressor component measurements for gas processing facilities.

Compressor Type	Compressor Component	Compressor Operating Mode
Wet Seal Centrifugal Compressors	Blowdown valve	Operating
	Wet seal oil degassing vents	Operating
	Isolation valve	Non-operating, depressurized
Dry Seal Centrifugal Compressors	Blowdown valve	Operating
	Isolation valve	Non-operating, depressurized
Reciprocating Compressors	Blowdown valve	Operating
	Rod packing	Operating
	Blowdown valve	Stand-by pressurized
	Isolation valve	Non-operating, depressurized

A significant amount of compressor information is reported to the GHGRP. Care must be taken in utilizing this information for emission factor development. While both measured and unmeasured CH₄ emissions data are reported separately for isolation valves, the measured data should be considered to be the most appropriate for developing a national emission factor. Regulatory revisions, which included additional reporting elements for the measured flow rate and measurement methods, as well as revised Envirofacts data tables prompted different data analysis approaches for RY2015 GHGRP data than for earlier reporting years. Some of the revisions to the RY2015 GHGRP data included:

- Calculating and reporting emissions from compressors that are routed to an operational flare with other flare stack emissions.
- Combining emissions from wet seal and dry seal centrifugal compressors. (Activity data for wet and dry seal compressors are reported separately).
- Combining emissions from reciprocating compressor blowdown valves in operating and standby mode.
- Separating the reporting elements for the compressor source (wet seal degassing, rod packing, isolation valve, or blowdown valve) from the emissions. For RY2015, the reported leak identifiers were assigned to these categories by manually combining data from multiple Envirofacts tables.
- Separating the reporting elements for time in operating and not-operating modes from the reported emissions and emission measurements.
- Revising the reporting requirements for compressor venting sources to only yes/no indicators for the sources routed to flare, combustion, or vapor recovery. Previous years reported flared emissions and the fraction of gas recovered by different methods as separate compressor data elements.

The addition of the measured flow rate and measurement method in the GHGRP RY2015 data enabled evaluation of reported measurements of zero emissions. The GHGRP RY2015 data were filtered to exclude acoustic flow measurements due to the uncertainty associated with that measurement method. The data were also filtered to retain all data sets where both methane emissions and corresponding measured flow rates were reported.

The GHGRP RY2013 and GHGRP RY2014 data analyses included data sets reporting measured CH₄ emissions that are equal or greater than zero tonnes CH₄ per year. However, the same data filters applied to the RY2015 GHGRP data (excluding acoustic measurements and inconsistent data sets) cannot be used for the RY2013 and RY2014 data sets since the data elements used for these filters were not available prior to RY2015. For RY2013 and RY2014, data were filtered based on operational or non-operational hours greater than zero (where applicable to the specific source) and measured emissions greater than or equal to zero. Data for RY2012 and RY2011 were not included in the analysis due to the potential use of Best Available Monitoring Method (BAMM) in place of actual measurements. Table 5 and 6 summarize API's analysis of the GHGRP data for centrifugal and reciprocating compressors, respectively.

Table 5. GHGRP data for centrifugal compressors in gas processing.

	RY2015 Data	RY2014 Data	RY2013 Data	Comments
Wet Seal Degassing Emissions				
# compressors with wet seals	264	275	277	For comparison with data subsets
# wet seal compressors with measured seal gas emissions >=0	124	156	144	Filters data sets for wet seal compressors with measured emissions >=0. 2014 and 2013 data are also filtered for operating hours >0, and with # seals >0
Total annual CH ₄ emissions for wet seal degassing, tonnes CH ₄	10,920	12,945	10,532	
Tonnes CH ₄ /compressor	88.06	82.98	73.14	
Mscfy CH ₄ /compressor	4,587	4,322	3,809	Applies density of 0.0192 kg CH ₄ /scf CH ₄

	RY2015 Data	RY2014 Data	RY2013 Data	Comments
% compressors with controls	20%	9.3%	0%	From data sets with wet seal degassing vents and indication of controls. 2014 and 2013 data sets are filtered for measured emissions >=0
Centrifugal Compressor Isolation Valves (dry and wet seal compressors combined)				
# wet and dry seal centrifugal compressors	478	461	460	For comparison with data subsets
# centrifugal compressors with measured isolation valve emissions >=0	24	90	81	Filters data sets for isolation valves with measured emissions >=0. 2014 and 2013 data are also filtered for non-operating hours >0
Total annual CH ₄ emissions for centrifugal compressor isolation valves, tonnes CH ₄	53.76	3,716*	718	
Tonnes CH ₄ /compressor	2.24	41.29*	8.87	
Mscfy CH ₄ /compressor	116.7	2,150*	461.8	Applies density of 0.0192 kg CH ₄ /scf CH ₄
% compressors with controls	35%	18.9%	23.5%	From data sets with isolation valve emissions and indication of controls. 2014 and 2013 data sets are filtered for measured emissions >=0.
Centrifugal Compressor Blowdown Valves (dry and wet seal compressors combined)				
# centrifugal compressors with measured blowdown valve emissions >=0	112	226	201	Filters data sets for blowdown valves with measured emissions >=0. 2014 and 2013 data are also filtered for operating hours >0
Total annual CH ₄ emissions for wet seal compressors above, tonnes CH ₄	295.1	848.2	2,828	
Tonnes CH ₄ /compressor	2.63	3.75	14.07	
Mscfy CH ₄ /compressor	137.2	195.46	732.87	Applies density of 0.0192 kg CH ₄ /scf CH ₄
% compressors with controls	34%	19.9%	15.4%	From data sets with blowdown valve emissions and indication of controls. 2014 and 2013 data sets are filtered for measured emissions >=0.

*Using all measurement data including potential outliers. See further discussion on outlier identification and data presentation in Figure 1 and Table 7 below.

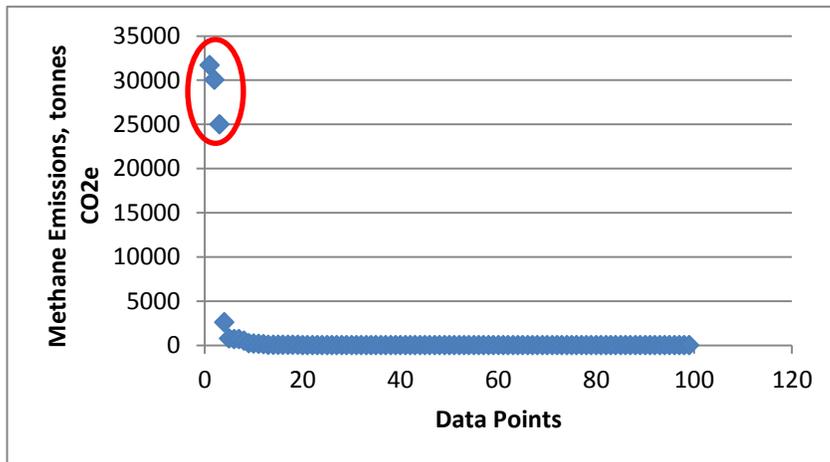
Table 6. GHGRP data for reciprocating compressors in gas processing.

	RY2015 Data	RY2014 Data	RY2013 Data	Comments
Reciprocating Compressor Blowdown Vents (operating and standby modes combined)				
# reciprocating compressors	2,662	2,642	2,648	For comparison with data subsets
# recip compressors with measured blowdown valve emissions >=0	430	1,600	1,175	Filters data sets for recip. compressors with measured blowdown emissions >=0. 2014 and 2013 data are also filtered for operating + standby hours >0
Total annual CH ₄ emissions for recip compressors above, tonnes CH ₄	2,236	3,911	5,131	
Tonnes CH ₄ /compressor	5.20	2.44	4.37	
Mscfy CH ₄ /compressor	270.83	127.31	227.44	Applies density of 0.0192 kg CH ₄ /scf CH ₄
% compressors with controls	31%	23%	17%	From data sets with blowdown valve emissions and indication of controls.

	RY2015 Data	RY2014 Data	RY2013 Data	Comments
				2014 and 2013 data sets are filtered for measured emissions >=0.
Reciprocating Compressor Isolation Valves				
# recip compressors with measured isolation valve emissions >=0	165	498	447	Filters data sets for recip compressors with measured isolation valve emissions >=0. 2014 and 2013 are also filtered for non-operating hours >0
Total annual CH ₄ emissions for recip compressors above, tonnes CH ₄	284.78	1,818	1,476	
Tonnes CH ₄ /compressor	1.73	3.65	3.30	
Mscfy CH ₄ /compressor	89.89	190.14	172.02	Applies density of 0.0192 kg CH ₄ /scf CH ₄
% compressors with controls	30%	20%	17%	From data sets with isolation valve emissions and indication of controls. 2014 and 2013 data sets are filtered for measured emissions >=0.
Reciprocating Compressor Rod Packing				
# recip compressors with measured rod packing emissions >=0	1,239	1,405	1,140	Filters data sets for recip compressors with measured rod packing emissions >0. 2014 and 2013 are also filtered for operating hours >0.
Total annual CH ₄ emissions for recip compressors above, tonnes CH ₄	23,505	27,586	31,575	
Tonnes CH ₄ /compressor	18.97	19.63	27.70	
Mscfy CH ₄ /compressor	988	1,023	1,443	Applies density of 0.0192 kg CH ₄ /scf CH ₄
% compressors with controls	13%	23%	20%	From data sets with rod packing emissions and indication of controls. 2014 and 2013 data sets are filtered for measured emissions >=0.

The GHGRP data requires careful review and screening to avoid data outliers from disproportionately impacting the derivation of emission factors (EFs) or extrapolation of potentially erroneous information for inclusion in the national GHGI. For example, review of the GHGRP data for isolation valves revealed three potential outlier data points in RY2014, as shown in Figure 1.

Figure 1. Distribution of measured isolation valve methane emissions for RY2014.



Removing these three data points, which are shown to be extremely inconsistent with over 99% of the other data points, significantly impacts the analysis results and changes the RY2014 GHGRP results for Isolation Valves. The data presented in Table 7 offer an insight to the importance of properly screening data prior to deriving emission factors and the impact it has on the results of the analysis for Isolation Valves.

Table 7. Comparison of RY2014 GHGRP data for centrifugal compressors: isolation valves (dry and wet seal compressors combined).

	Including Outliers	With Outliers Removed
# Centrifugal Compressors with measured isolation valve emissions >=0	90	87
Total annual CH ₄ emissions for centrifugal compressor isolation valves, tonnes CH ₄	3,716	247
Tonnes CH ₄ /compressor	41.29	2.84
Mscfy CH ₄ /compressor	2,150	147.8

REVISED GAS PROCESSING COMPRESSOR EMISSION FACTORS FOR THE GHGI

The fugitive emission factor used in the GHGI for gas processing compressors is a composite of average fugitive emissions for specific components associated with each compressor type. The initial basis for the compressor emission factors was from data collected in the early 1990's.⁶ The emission factors considered all leaking components on the compressor itself or immediately adjacent to it. The components included for each compressor type are shown in Table 8.

Table 8. Summary of components included in the GHGI compressor fugitive emission factors.

Wet Seal Centrifugal Compressor Components	Dry Seal Centrifugal Compressor Components	Reciprocating Compressor Components	Notes
Miscellaneous	Miscellaneous	Miscellaneous	Includes other components such as cylinder valve covers and fuel valves
Compressor Starter Open Ended Line	Compressor Starter Open Ended Line	Compressor Starter Open Ended Line	Included as part of general fugitive emissions under the GHGRP, not as part of the compressor fugitive emissions.
Compressor Blowdown Open Ended Line	Compressor Blowdown Open Ended Line	Compressor Blowdown Open Ended Line	Measured in the "as-found" mode as part of the GHGRP
Isolation Valve	Isolation Valve	Isolation Valve	Measured in the "as-found" mode or once every 3 years as part of the GHGRP
Compressor Wet Seal Degassing	Compressor Dry Seal	Rod Packing	Wet seals and reciprocating rod packing emissions are measured as part of the GHGRP. Centrifugal compressor dry seals are not included in the GHGRP.

Tables 9a, 9b, and 10 compare the emission factors previously used in the GHGI to measured component emissions reported through the GHGRP. Outlier data points from the GHGRP data identified above have been removed for this analysis.

Tables 9a and 9b present the compressor source data used to derive emission factors for wet and dry seal centrifugal compressors, respectively. The GHGRP data are presented separately for RY2013, RY2014, and RY2015. A weighted average of the GHGRP data for all three years is then used to derive an updated emission factor. For those compressor sources with controls, a 98% control efficiency was assumed to account for both the operational time of the control device (the majority were reported as 100% operational) and the combustion efficiency of the control device. The previous 2016GHGI (RY2014) data⁷ are presented for comparison. Table 10 presents the emission factor data in the same format for reciprocating compressors.

Table 9a. GHGI and GHGRP Data for wet seal centrifugal compressor emission factor.

Component	Mscfy CH ₄ /component (not controlled)				GHGRP Weighted Average % Controlled	Mscfy CH ₄ /compressor
	2016 GHGI Data RY2014	RY2013 GHGRP Data	RY2014 GHGRP Data	RY2015 GHGRP Data		GHGRP Weighted Average EF (includes controls)
Compressor Starter Open-ended Line	1,341					(Included with fugitive emissions)
Miscellaneous	31					31
Isolation Valve (dry and wet seal compressors)	Not included	462	148	117	31%	192
Blowdown Vent (dry and wet seal compressors)	6,447	733	195	137	26%	286
Compressor Seal (Wet seal degassing)	10,930	3,809	4,322	4,587	12%	3,739
<i>Annual Compressor EF, Mscfy CH₄/compressor</i>	<i>18,749</i>					<i>4,248</i>
<i>Daily Compressor EF, scfd CH₄/compressor</i>	<i>51,369</i>					<i>11,638</i>

Table 9b. GHGI and GHGRP data for dry seal centrifugal compressor emission factor.

Component	Mscfy CH ₄ /component (not controlled)				Weighted Average % Controlled	Mscfy CH ₄ /compressor
	2016 GHGI Data RY2014	RY2013 GHGRP Data	RY2014 GHGRP Data	RY2015 GHGRP Data		GHGRP Weighted Average EF (includes controls)
Compressor Starter Open-ended Line	1,341					(Included with fugitive emissions)
Compressor Seal (Dry)	1,374					1,374
Miscellaneous	31					31
Isolation Valve	Not Included	462	148	117	31%	192
Blowdown Vent	6,447	733	195	137	26%	286

<i>Annual Compressor EF, Mscfy CH₄/compressor</i>	9,193					1,883
<i>Daily Compressor EF, scfd CH₄/compressor</i>	25,186					5,158

Table 10. GHGI and GHGRP Data for reciprocating compressor emission factor.

Component	Mscfy CH ₄ /component (not controlled)				Weighted Average % Controlled	Mscfy CH ₄ /compressor
	2016 GHGI Data RY2014	RY2013 GHGRP Data	RY2014 GHGRP Data	RY2015 GHGRP Data		GHGRP Weighted Average EF (includes controls)
Compressor Starter Open-ended Line	335					(Included with fugitive emissions)
Pressure Relief Valve	349					(Included with fugitive emissions)
Miscellaneous	189					189
Blowdown Vent	2,035	227	127	271	26%	137
Isolation Valve	Not Included	172	190	90	27%	124
Rod Packing	1,125	1,443	1,023	988	17%	943
<i>Annual Compressor EF, Mscfy CH₄/compressor</i>	4,033 (potential)					1,678 (w/out controls) 1,393 (with controls)
<i>Daily Compressor EF, scfd CH₄/compressor</i>	11,194¹ (net)					3,817 (with controls)

Comparison of Emission Factors

Table 11 compares EPA's calculated 2016 GHGI (RY 2014)⁷ emission factors and EPA's revised 2017 GHGI (RY 2015)⁶ emission factors to the emission factors resulting from API's analysis of GHGRP data for centrifugal compressors. The data in Table 11 show that utilizing the GHGRP data results in lower emission factors than the factors used in the 2016 GHGI (RY 2014). The key difference between the emission factors used by EPA in the 2017 GHGI (RY 2015) and the emission factors developed from API's analysis is that EPA used all data reported to the GHGRP for RY2015, while API only used the GHGRP measured data and corrected for the percentage of compressors with controls. API also recommends the emission factor be based on a three year average of the GHGRP data due to data variability, but API's results using just the RY2015 GHGRP data are shown in Table 11 for comparison to EPA's approach.

¹ The GHGI reports a potential emission factor of 11,196 scfd CH₄/compressor, and then applies reduction from Gas STAR of 0.1 ktonnes CH₄/yr. This results in a net emission factor of 11,194 scfd CH₄/compressor for reciprocating compressors. The GHGRP data presented represent uncontrolled emissions.

Table 11. Comparison of Centrifugal Compressor Emission Factors, tonnes CH₄/compressor.

Average annual CH ₄ emissions per compressor (tonnes CH ₄ /compressor)	2016 GHGI RY2014	2017 GHGI RY2015	API's Analysis of GHGRP Data (average 2013-2015)	API's Analysis using RY2015 GHGRP Data Only
Wet Seal Compressors	361	57	82	75
Dry Seal Compressors	177	30	36	30

Table 12 compares the 2016 GHGI (RY2014)⁷ emission factor, revised 2017 GHGI (RY2015)⁶ emission factor, and emission factor resulting from API's analysis of GHGRP data for reciprocating compressors. The 2017 GHGI (RY2015) emission factor is lower than the approach recommended by API because EPA analysis used all the GHGRP data, not just the measured values, and EPA's emission factor reflects only GHGRP RY2015 data (there is a general downward trend in the GHGRP data for reciprocating compressor emissions).

Table 12. Comparison of Reciprocating Compressor Emission Factors, tonnes CH₄/compressor.

	2016 GHGI RY2014	2017 GHGI RY2015	API's Analysis of GHGRP Data (average 2013-2015)	API's Analysis using RY2015 GHGRP Data Only
Average annual CH ₄ emissions per compressor (tonnes CH ₄ /compressor)	79	19	27	25

CONCLUSIONS

EPA's revisions to well counts used in the national GHG inventory is a significant improvement for the characterization of emissions from petroleum and natural gas production operations, API continues to encourage EPA to be transparent in the process that the agency uses to develop their national well counts and to share their underlying data.

For gas processing facilities in the GHGI, API recommends using the GHGRP ratio of centrifugal and reciprocating compressors per gas plant to extrapolate the number of compressors nationally, based on the national gas plant count provided by the EIA survey. Due to regulations controlling emissions from compressors, which may lead to changes in the types of compressors used in the future, we expect to see the counts of compressors by type to vary year to year. Therefore, it would be appropriate to update the ratio of compressors to gas plants each year based on the GHGRP data.

The emission factors presented in this paper include the new GHGRP data available for RY2015, as well as any updates reported for RY2013 and RY2014. Data reported for RY2015 included revised reporting elements which changed the approach for analyzing the data compared to previous years. However, for all reporting years, the emissions data reflected in this memo only include measured emissions and excluded data inconsistencies.

The emission factors presented in Tables 9a, 9b, and 10 exclude emissions from starter open ended lines, which are reported under equipment leaks in the GHGRP. For centrifugal compressors, three outlier isolation valve data points were excluded for RY2014. The emission factors presented in Tables 9a, 9b, and 10 also include corrections to account for controls (flaring, vapor recovery, or captured for combustion) and GHGRP data sets reporting zero methane emissions. The data in Tables 9a, 9b and 10 reflect current operating practices, as well as leak repair practices implemented by the reporting companies as a result of monitoring the compressors. Since controls are included in the emission factors derived from the GHGRP data, use of these factors in the GHGI should be on a net emission basis and should not separately account for reductions reported through Gas STAR.

ACKNOWLEDGEMENT

The authors would like to recognize the contribution of API member companies in the review of the GHGRP data. API would also like to acknowledge the collaboration with EPA's Climate Change Division and on-going efforts to develop the characterization of industry emissions in the annual national GHG inventory

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KEY WORDS

Greenhouse gases
Emission inventories
Emission factors
Petroleum and Natural Gas
Production wells
Compressors