OIL AND GAS PROCESSES AND EMISSIONS

This document provides a brief description of oil and gas activities, equipment and expected pollutants from those equipment types. The emissions processes are discussed in order of larger sources to smaller, specifically for:

(a) large compressor stations,
(b) large gas processing plants
(c) stand alone production sites, and
(d) wellhead/small compressor stations.

In reported emission inventories, large compressor stations and gas processing plants are likely included as point sources, if they are large enough and permitted. Other emissions sources reported would be in the area sources emissions files.

The primary focus of our analysis will be on NOx emissions, and we will estimate VOC emissions for some processes. Oil and gas NOx emissions are mostly from internal combustion engines (ICEs). The three types of equipment/processes that are expected to contribute significantly to NOx emissions are:

- Natural gas-fired compressor engines;
- ICEs use to power drilling rigs; and
- ICEs used to power generators in coal bed methane (CBM) production.

LARGE COMPRESSOR STATIONS (100 MMSCFD AND ABOVE)

These sites are usually associated with interstate gas transmission lines but also may be found in some collection systems that bring gas from well sites and processing plants to main transmission lines. These facilities usually have very large compressors, either reciprocating or turbine driven, to accommodate the large volumes of natural gas to be delivered into the transmission pipeline. Examples of this type of facility are Kinder Morgan Interstate Gas Transmission Co. and El Paso Natural Gas Co. The large compressor stations along main transmission lines (an example of which is shown in Figure 1) are expected to be permitted as major point sources.

Figure 1. Large Compressor Station (American Central Gas Compressor Station; Carthage, TX).

I) Internal Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Natural Gas Fired Engines:
Compressors [Reciprocating & Turbine], Generators

b) Diesel Fired Engines:
The emergency diesel generator used at a compressor station is not used normally under a continual service.

II) External Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Line Heater: This is used to maintain the temperature of the gas to reduce the formation of natural gas hydrates in the transmission lines.

b) Glycol Regenerator: This is used to drive off the water that has been absorbed by the glycol when the "wet" natural gas was bubbled through it.

c) Combustion Flare: Normally used under emergency conditions, will handle emergency blow downs, vents and uncontrolled, unscheduled VOC emissions

III) Storage and Separation Vessels (VOC):

a) Fugitives: This can be calculated on an estimated valve and connector count based on the type of skid, i.e. compressor, dehydration, etc.

b) Glycol dehydrator Flash Tank: The TEG, once it has contacted the high pressure natural gas, will have a discrete amount of the gas dissolved into it. A portion of the natural gas will be removed from the TEG at this stage due to a pressure drop. This gas is similar in composition to the natural gas that was dehydrated.

c) Glycol dehydrator Regenerator Still Column: The glycol will release the water and entrained hydrocarbon under the heat of the regenerator reboiler. This will usually contain C6+.

d) Storage Tanks: This group includes both hydrocarbon and water storage tanks. Salt water storage tanks must also be considered as possible hydrocarbon emission sources as

some water separation techniques leave a layer of oil on top of the water that contributes to the overall emissions.

e) Pressure & Level Controllers (Natural Gas Supplied): These items control the vessel levels and pressure ranges. Certain older models can vent continuously and at a rate of up to 1,000 cubic feet per day (1 MCFD). There could be several hundred controllers at a compressor station.

f) Gas Operated Pumps (GOP) & Chemical Injection (CI) Pumps: Normally used to move fluids from one storage vessel to another. The CI pumps are used to inject corrosion, scale and biological inhibitors into flow lines. Although the gas usage for these is small there can be significant numbers of CI pumps at wells sites at the wellhead.

NATURAL GAS PROCESSING PLANTS

These sites are usually associated with the production of oil & gas at the field level. An example of such a plant is the Lost Cabin Gas Plant (Lost Cabin, WY), shown in Figure 2. These sites have all the equipment necessary to fractionate, sweeten, treat/dehydrate, and compress natural gas. The Lost Cabin Gas Plant processes more than 300 MMSCF per day. These sites include similar equipment as the intermediate size facilities discussed below. They are treated separately here due to their size and the resulting expectation that they are permitted as point sources.

Figure 2. Lost Cabin Gas Plant (shown during construction of enclosing structure).

I) Internal Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Natural Gas Fired Engines:
Compressors [Reciprocating & Turbine (occasional use)], Generators & Pumping Units: The only issue may be the loading on the pumping units. The upstroke is the one that uses the most power.

b) Diesel Fired Engines:
Generators: The diesel generator is not used normally under a continual service.

II) External Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Separators (High, Intermediate & Low): If there is no source to readily accept the pressurized gas, compression or combustion flare, the vessel will vent to the atmosphere to maintain the flow of the liquid to the other separators, treatment and storage vessels.
b) Glycol Regenerator: This is used to drive off the water that has been absorbed by the glycol when the "wet" natural gas was bubbled through it.
c) Amine Regenerator: This is used to remove the entrained pollutants from the fluid used in a "Sweetening Unit". These pollutants usually are CO_2 & H_2S which may be flared, vented directly to the atmosphere or sent to a sulfur recovery unit. Sulfur Recovery Unit: This is used to recover sulfur collected off the amine regenerator. Residual pollutants can include reduced sulfur compounds or sulfur dioxide depending on the tail gas treatment system used.
d) Combustion Flare: Normally used under emergency conditions, will handle emergency blow downs, vents and uncontrolled, unscheduled VOC emissions.

III) Storage and Separation Vessels (VOC):

a) Fugitives: This can be calculated on an estimated valve and connector count based on the type of skid, i.e. compressor, dehydration, etc.
b) Separators (High, Intermediate & Low): If there is no source to readily accept the pressurized gas, compression or combustion flare, the vessel will vent to atmosphere to maintain the flow of the liquid to the other separators, treatment and storage vessels.
c) Glycol Flash Tank: The glycol, once it has contacted the high-pressure natural gas, will have a discrete amount of the gas dissolved into it. A portion of the natural gas will be removed from the glycol at this stage due to a pressure drop. This gas is similar in composition to the natural gas that was dehydrated.
d) Glycol Regenerator Still Column: The glycol will release the water and entrained hydrocarbon under the heat of the regenerator reboiler. This will usually contain C6+.
e) Storage Tanks: This group includes both hydrocarbon and water storage tanks. Salt water storage tanks must also be considered as possible hydrocarbon emission sources as some water separation techniques leave a layer of oil on top of the water that contributes to the overall emissions. Condensate (hydrocarbons recovered from natural gas) storage is usually controlled with vapor recovery units, although flares may be used as a backup or alternative control technology.
f) Pressure & Level Controllers (Natural Gas Supplied): These items control the vessel levels and pressure ranges. Certain older models can vent continuously and at a rate of 1,000 cubic feet per day (1 MCFD). There could be several hundred controllers at a compressor station.

INTERMEDIATE SIZE FACILITIES (STAND ALONE PRODUCTION SITES)

These sites are usually associated with the production of oil & gas at the field level. An example of this type of facility is shown in Figure 3. These sites have all the equipment necessary to produce, separate, treat/dehydrate, compress the natural gas and store the produced oil.

Figure 3. Small Natural Gas Processing Plant (Denton County, Texas).

I) Internal Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Natural Gas Fired Engines: Compressors [Reciprocating & Turbine (occasional use)], Generators & Pumping Units: The only issue may be the loading on the pumping units. The upstroke is the one that uses the most power.
b) Diesel Fired Engines:
Generators: The diesel generator is not used normally under a continual service.

II) External Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Line Heater: This is used to heat the fluid after it takes a pressure drop through the "choke" at the wellhead
b) Separators (High, Intermediate & Low): If there is no source to readily accept the pressurized gas, compression or combustion flare, the vessel will vent to atmosphere to maintain the flow of the liquid to the other separators, treatment and storage vessels.
c) Heater Treaters: This is used to break a multiphase emulsion of oil/water/gas in the fluid.
d) Glycol Regenerator: This is used to drive off the water that has been absorbed by the glycol when the "wet" natural gas was bubbled through it.
e) Amine Regenerator: This is used to remove the entrained pollutants from the fluid used in a "Sweetening Unit". These pollutants usually are CO_2 & H_2S and are emitted from a different source detailed below.
f) Combustion Flare: Normally used under emergency conditions, will handle emergency blow downs, vents and uncontrolled, unscheduled VOC emissions.

III) Storage and Separation Vessels (VOC):

a) Fugitives: This can be calculated on an estimated valve and connector count based on the type of skid, i.e. compressor, dehydration, etc.

b) Separators (High, Intermediate & Low): If there is no source to readily accept the pressurized gas, compression or combustion flare, the vessel will vent to the atmosphere to maintain the flow of the liquid to the other separators, treatment and storage vessels.
c) Glycol Flash Tank: The glycol, once it has contacted the high-pressure natural gas, will have a discrete amount of the gas dissolved into it. A portion of the natural gas will be removed from the glycol at this stage due to a pressure drop. This gas is similar in composition to the natural gas that was dehydrated.
d) Glycol Regenerator Still Column: The glycol will release the water and entrained hydrocarbon under the heat of the regenerator reboiler. This will usually contain C6+.
e) Storage Tanks: This group includes both hydrocarbon and water storage tanks. Salt water storage tanks must also be considered as possible hydrocarbon emission sources as some water separation techniques leave a layer of oil on top of the water that contributes to the overall emissions.
f) Pressure & Level Controllers (Natural Gas Supplied): These items control the vessel levels and pressure ranges. Certain older models can vent continuously and at a rate of up to 1,000 cubic feet per day (1 MCFD).
g) Gas Operated Pumps (GOP) & Chemical Injection (CI) Pumps: Normally used to move fluids from one storage vessel to another. The CI pumps are used to inject corrosion, scale and biological inhibitors into flow lines.
h) Storage Tanks: This group includes both hydrocarbon and water storage tanks. Salt water storage tanks must also be considered as possible hydrocarbon emission sources as some water separation techniques leave a layer of oil on top of the water that contributes to the overall emissions.
i) Oil/Water Skimmers (Floatation Cells/WEMCO Units): The use of natural gas that is bubbled through the produced water to released additional entrained oil is common and often not accounted for in emission inventories.

SMALL COMPRESSOR STATIONS & WELLHEAD SITES

These sites are the smallest of the locations under review. These may have a small portion of the equipment described above in discrete locations. Most small compressor stations handle natural gas volumes in a range between 100 MSCFSD to <10 MMSCFD. Usually these sites are utilized to pressurize the natural gas so it can be transported in a sale pipeline connected to a large compressor station described above. An example of such a small site is shown in Figure 4.

Figure 4. Small Compressor Station (Montana).

The wellhead locations usually consist of a well head and, on some locations, a test separator to estimate the ratio of oil, water and natural gas in the production stream. These sites are usually connected to a common production header and are routed to an intermediate site or commingling facility to handle the fluid from multiple well sites more efficiently.

Examples of these types of fields would be the Elkhorn Ranch or Morgan Draw Field (North Dakota). This type of location is the most numerous of the three categories.

I) Internal Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Natural Gas Fired Engines: Compressors [Reciprocating] & Pumping Units: The only issue may be the loading on the pumping units. The upstroke is the one that uses the most power.

b) Diesel Fired Engines:

(i) Generators and prime movers for drilling operations: Onshore drilling operations usually utilize diesel engines for mechanical pump power and electricity generation.

(ii) Generators for CBM operations: Diesel generators are also used for coal-bed methane production to power water pumps. This occurs in remote areas where line power is not accessible.

II) External Combustion Sources (NO_x, PM10/PM2.5, VOC, SO_x & CO):

a) Line Heater: This is used to heat the fluid after it takes a pressure drop through the "choke" at the wellhead

b) Glycol Regenerator: This is used to drive off the water that has been absorbed by the glycol when the "wet" natural gas was bubbled through it.

III) Storage and Separation Vessels (VOC):

a) Fugitives: This can be calculated on an estimated valve and connector count based on the type of skid, i.e. compressor, dehydration, etc.

b) Separators: If there is no source to readily accept the pressurized gas, compression or combustion flare, the vessel will vent to the atmosphere to maintain the flow of the liquid to the other separators, treatment and storage vessels.

c) Glycol Flash Tank: The glycol, once it has contacted the high-pressure natural gas, will have a discrete amount of the gas dissolved into it. A portion of the natural gas will be removed from the glycol at this stage due to a pressure drop. This gas is similar in composition to the natural gas that was dehydrated.
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