**ANALYSIS OF AIR POLLUTION IN TEXAS**

1. **Most and least polluting products of Texas**

In terms of pollution in Texas, crude petroleum and natural gas (total of approx. 14004 Tpy of pollutants emitted) is the most polluting product as it emits more than 4000 Tpy of voc and more than 1000 Tpy of nox which is more than any other product and the least polluting product is industrial gases (total of approx. 876 tpy of pollutants emitted) as seen in plot 1.

1. **Comparing total emission levels of pollutants by products**

|  |  |  |
| --- | --- | --- |
| **Pollutant** | **Product with maximum emission** | **Maximum quantity emitted (in TPY)** |
| Co | Crude petroleum & natural gas | 2107.8006 |
| Nox | Crude petroleum & natural gas | 4221.0131 |
| Pm10 | Crude petroleum & natural gas | 139.7974 |
| Pm2.5 | Crude petroleum & natural gas | 137.4104 |
| So2 | Crude petroleum & natural gas | 1034.3007 |
| Voc | Crude petroleum & natural gas | 6363.6135 |

|  |  |  |
| --- | --- | --- |
| **Pollutant** | **Product with minimum emission** | **Minimum quantity emitted (in TPY)** |
| Co | Industrial gases | 223.1659 |
| Nox | Industrial gases | 265.7003 |
| Pm10 | Natural gas transmission | 73.3215 |
| Pm2.5 | Plastics materials and synthetic resins | 67.8641 |
| So2 | Plastics materials and synthetic resins | 1.6864 |
| Voc | Industrial gases | 66.7980 |

As seen in the above table, Maximum emission of all pollutants is by Crude petroleum and natural gas, thus reiterating the previous point about crude petroleum and natural gas being the most harmful product. This is graphically represented in plot 2.

1. **Most and least abundant pollutants of Texas**

|  |  |
| --- | --- |
| **Pollutant** | **Total quantity emitted (in TPY)** |
| nox | 9364.9781 |
| voc | 9325.8888 |
| co | 5997.5167 |
| so2 | 1435.7309 |
| pm10 | 589.2751 |
| pm2.5 | 521.1663 |

As seen in plot 3 and the above table, the most emitted pollutant in Texas is nox as its total quantity of emission is the highest (approx. 9365 Tpy). The least emitted pollutant in Texas is pm2.5 with the least total quantity emitted (approx. 521 Tpy).

1. **Analysis of pollution by each product in Texas** (using graphs from plot 4)

* The main observation of the graph of crude petroleum and natural gas is the outlier in emissions of voc. This quantity is 4315 Tpy by Copano field services south Texas LLC at its site compressor station in the county, Live oak. This emission is much more in comparison to any other emission of crude petroleum and natural gas contributing to its most polluting nature.
* The graph for natural gas transmission show that its highest quantity of pollutant emitted is of the pollutant co (approx. 250 Tpy). Its least emission is of so2.
* The graph for natural gas liquids show that the highest quantity of pollutant emitted is for nox (more than 500 Tpy) and the least is for so2. There are two main outlier points- first for co (above 400 Tpy, all other emission points below 200 Tpy), second for nox (more than 500 Tpy, all other emission points below 300 tpy).
* The graph for plastic material and resin shows that its highest quantity of pollutant emitted is for voc and the least is for so2. There are major outlier quantities emitted for co (all emissions below 200 Tpy, only one point above 400 Tpy) and nox (all emissions below 100 Tpy only one point above 400 Tpy).
* The graph for the least polluting product, industrial gases shows that most of its emissions of pollutants are below 50 Tpy with a few outlier emission points above this. Nox has an outlier above 150 Tpy.

1. **The top ten percentile polluters are the most polluting**

There are 17 companies in the top ten percentile of each pollutant.

The general trend observed for all pollutants is that the companies in the top ten percentile are responsible for the maximum proportion of the total emission levels for each pollutant.

* The following table shows the most polluting company for each pollutant.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Pollutant** | **Company** | **Site** | **County** | **Product description** | **Quantity emitted**  **(in TPY)** |
| Co | EIC field services LLC | Tippet gas plant | Crockett | Natural gas liquids | 467.3104 |
| Nox | Oxy USA INC | Block 31 gas plant | Crane | Crude petroleum & natural gas | 1184.7800 |
| Pm10 | Air products LLC | Port Arthur facility | Jefferson | Industrial gases | 95.6978 |
| Pm2.5 | Air products LLC | Port Arthur facility | Jefferson | Industrial gases | 86.0911 |
| So2 | Pioneer natural  resources USA INC | Pawnee gas plant | BEE | Crude petroleum &  natural gas | 354.2593 |
| Voc | Copano field services south Texas LLC | Compressor  station | Live oak | Crude petroleum &  natural gas | 4314.5525 |

* The graphs showing emission levels for co, nox, pm10, pm2.5 show a common trend. Most companies emitting these pollutants are clustered on the lower emission levels. But surprisingly the top ten percentile group i.e. only the top 17 companies out of 162 are responsible for 50-60% of the total emission of each of these pollutants. The top ten percentile emits 52% of the total emission of co, 54% of the total emission of nox, 60% of the total emission of pm10 and 58% of the total emission of pm2.5.
* The graph for so2 also shows maximum clustering of companies on the lower emission levels particularly at zero. But analysis shows that the top ten percentile group i.e. only 17 out of 162 companies emit 97% of the total emission levels of so2. Thus, we can say that particularly for so2 only a group of companies are responsible for emission.
* All companies emitting voc are below the 500 Tpy point except 2 companies. But there is one very distinct outlier emitting more than 4000 Tpy of voc. Because of this outlier the fraction of total emissions of voc for the top ten percentile group becomes 75%.
* Thus, for all pollutants since the top ten percentile group is responsible for maximum pollution, policies can be implemented targeting this top tier to cut down their levels of emission especially in case of so2 and voc.

1. **County wise analysis**

If pollution is taken as the main criteria to decide how safe a place is for living in Texas, then live oak is the most unsafe county and Crane is the second most unsafe county to live in. Similarly, Polk is the safest county to live in and Terral is the second safest county to live in.

The pollutant emission levels of the top 2 counties that suffer the most because of pollution are shown in the following table (total emission given in TPY). (Ref. graph1, graph2)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **County** | **Total co**  **emission** | **Total nox**  **emission** | **Total pm10**  **emission** | **Total pm2.5**  **emission** | **Total so2**  **emission** | **Total voc**  **emission** | **Total pollutants emission** |
| Live Oak | 90.8707 | 67.7117 | 2.2196 | 2.2196 | 175.1246 | 4330.1628 | 4668.3090 |
| Crane | 206.6150 | 1437.708 | 33.6950 | 33.6950 | 11.8230 | 98.4010 | 1821.9370 |

The pollutant emission levels of the top 2 counties that suffer the least because of pollution are shown in the following table (total emission given in TPY). (Ref graph3, graph4)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **County** | **Total co**  **emission** | **Total nox**  **emission** | **Total pm10**  **emission** | **Total pm2.5**  **emission** | **Total so2**  **emission** | **Total voc**  **emission** | **Total pollutants emission** |
| Polk | 0.7300 | 0.3100 | 0.0100 | 0.0100 | 0.0000 | 4.7017 | 5.7617 |
| Terral | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.6350 | 0.6350 |