Vapor Lock in a Gasoline Fuel Supply System

Questions: Can PIPE-FLO Professional model vapor lock in a gasoline fuel supply system?

Answer: Yes.

Vapor lock occurs when the gasoline’s actual pressure falls below the gasoline’s vapor pressure point, somewhere along the fuel supply system. When this occurs, the gasoline changes from a liquid phase to a vapor phase and there are not enough gasoline molecules reaching the combustion chamber to maintain the proper air/fuel ratio. As a result, the engine does not run properly.

Characteristics that may affect the gasoline’s actual pressure falling below the vapor pressure point are listed below.

Gasoline Formulation:
- Summer formulation
- Winter formulation

Pressure Drop
- The suction of the pump is too high.
- The pressure drop across the fuel line is too high. This could be because the pipeline is too long, has too small of a diameter, and/or too many fitting or 90° elbows.
- The pressure drop across a fuel filter is too high.

Increase in Gasoline Temperature
- The ambient temperature increases, and thus the gasoline temperature increases.
- The fuel line or fuel pump is too close to the motor and absorber heat from the motor. This heat transfers into the gasoline and thus the gasoline temperature increase.

Elevation Change
- The fuel line rises up to a high point, then declines or falls back down creating a siphon effect.

Combinations of the above
- Pressure Drop plus Temperature Increase
- Temperature Increase plus Elevation Change

Today’s vehicles have the fuel pump located in the fuel tank. This solves most of the vapor lock issues by the pump having a flooded suction and being cooled by the gasoline. However, if the fuel line or fuel filter is too close to the motor (temperature increase) and there is a siphon effect (elevation change), a vapor lock can still occur.

Modeling a Vapor Lock in PIPE-FLO Professional:

The first step is obtaining the actual design information.

- Tank elevation and gasoline tank level
- Pipe sizes and pipe elevation changes
- Fuel filter pressure drop and elevation
- Fuel pump elevation, flow rate, and discharge pressure
- Fuel injector or carburetor elevation and any pressure requirements
- Any temperature engine hot spot locations, this would change the gasoline temperature in the fuel line.
Following is sample PIPE-FLO Professional model showing a vapor lock.

This model shows a tank, fuel line, filter, pump and a pressure source. A pressure source was used to model the fuel injector. PIPE-FLO turns devices red when there is a warning message. In this case, the message is "fluid changes state" and the message is shown below.

**Warnings**

The following exceptions were encountered during calculation.

- Pump: fluid changes state
- Component Filter: fluid changes state

This message is saying the system pressure has gone below the gasoline vapor pressure and it is changing from a liquid state to a vapor state. The gasoline fluid zone temperature is 213° F in this model.

Examples of gasoline temperature verses vapor pressure fluid property relationship are shown below.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Vapor Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>160° F</td>
<td>4.797 psi absolute</td>
</tr>
<tr>
<td>200° F</td>
<td>11.29 psi absolute</td>
</tr>
<tr>
<td>213° F</td>
<td>14.58 psi absolute</td>
</tr>
</tbody>
</table>
One can see how the vapor pressure increases as the temperature increases and the maximum fluid table temperature is 213°F.

Each of these temperature points can be a separate fluid zone. The higher temperature fluid zone can then be added to the fuel line closest to a hot spot on the engine for sensitivity analysis.

Additional sensitivity analysis is shown in the model below. This model has the filter pressure drop to be 0.2 psi g, the filter at the same elevation as the tank, and the gasoline temperature being 210°F. Under these conditions, the gas is not changing states.