

THE EFFECT OF PRESSURE ON THE AUTO-IGNITION TEMPERATURE OF CHEMICALS

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The Auto-Ignition Temperature (AIT) is the minimum temperature at which a chemical (e. g., vapor) will spontaneously ignite without an external ignition source such as a spark or pilot flame – under specific conditions – in an oxidant, which is usually air. Knowledge of the AIT of a material is very important in specifying storage and handling conditions, in eliminating potential hot surfaces or equipment, and in defining process operating conditions.

Most material safety data sheets (MSDS's) provided by the manufacturers of combustible or flammable liquids contain the AIT data. The data provided in MSDS's are generally from measurements conducted in air at atmospheric pressure. Typically, the AIT is measured using a standardized test method. Some of the common standard test methods used to determine AIT of chemicals is summarized below;

Standard	Test Method
ASTM D 2883	Standard Test Method for Reaction Threshold Temperature of Liquids and Solid Materials
ASTM E 659	Standard Test Method for Auto-Ignition Temperature of Liquid Chemicals
ASTM G72/G72M	Standard Test Method for Autogenous Ignition Temperature of Liquids and Solids in a High-Pressure Oxygen-Enriched Environment
DIN 51794	Determination of Ignition Temperature of Petroleum Products
BS 4056	Method of Test for Ignition Temperature of Gases and Vapors
IEC 79-4	Electric Apparatus for Explosive Gas Atmospheres – Part 4: Method of Test for Ignition Temperature

ASTM E 659 is one of the most widely used standards to determine the AIT of chemicals.

Factors Affecting the Auto-ignition Temperature

The AIT of a material can be influenced by a number of factors, including;

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| a. Vapor concentration | b. Vessel volume |
| c. System pressure | d. Oxidant concentration |
| e. Presence of catalytic material | f. Hot surface material |
| a. Duration of heating | h. Flow conditions. |

While variability is reduced by the use of a standard method, it is important to note that the AIT value indicated by a particular method does not necessarily represent the minimum temperature at which a material will self-ignite.

Although AIT data are available for common chemicals (usually measured in air at atmospheric pressure), very few data are available on the AIT of chemicals at elevated pressures and therefore such quoted values may not be useful when establishing the safe process temperature when the process is at a pressure other than atmospheric. Currently, there is no theoretical method to accurately calculate or predict the AIT of a chemical or mixtures at elevated pressures, and laboratory testing is required.

Test Methods to Determine AIT of Chemicals at Elevated Pressures

a. ASTM G72/G72M

This test method covers the determination of the temperature at which liquids and solids will spontaneously ignite. The test method is designed to expose a solid or liquid sample to increasing temperatures in a high-pressure vessel. The reaction vessel, including the sample-holding assembly is pressurized with the oxygen-enriched environment. The vessel is heated at a predetermined rate. The temperature of the sample-holding assembly is monitored as a function of time by means of thermocouple readout instrumentation connected to a data acquisition system.

Limitations:

- *The test method is intended for use at pressures of 300 to 3000 psig*
- *The test method is for liquids or solids with ignition temperatures in the range from 60 to 425°C*
- *No effort is made to control the system pressure during the heating process*
- *The sample amount is fixed at about 0.2 gms±0.03 grams*
- *Ignition will be difficult to determine if the sample volatilizes or distills to another part of the reaction vessel, before reaching the ignition temperature.*
- *Decomposition and oxidation of some fully-fluorinated materials release so little energy that a clear-cut indication of ignition may not be possible.*
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ASTM G72/G72M Test Apparatus

b. Custom/Modified ASTM E659

Chilworth has developed a custom “closed-bomb” apparatus based on the ASTM E659 methodology to conduct AIT testing of chemicals and chemical mixtures in air or other oxidants at elevated pressures, up to 4000 psig. The apparatus consists of a cylindrical pressure vessel which can be heated up to 500°C. Thermocouples and pressure transducers are used to monitor the system temperature and pressure. The sample is injected into the heated pressurized vessel, simulating the sample-addition method of ASTM E659. The sample concentration or quantity as well as the temperature of the vessel are varied to determine the AIT.



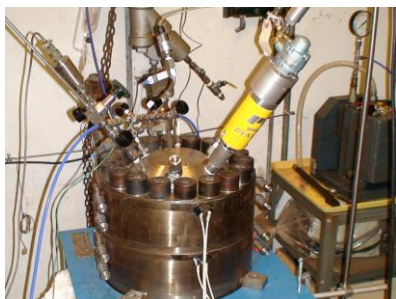
Custom High Pressure AIT Test Apparatus

Case Study – Effect of Pressure on Auto-ignition Temperature (AIT)

Reaction between high pressure air and compressor lubricants in high temperature inter-stage and discharge regions of a compressor can be a problem (i.e., overpressure due to auto-ignition). Two lubricant samples were tested in air at various pressures up to 2500 psig. The AIT for both lubricant samples at atmospheric conditions were not reported in their respective MSDS's. However, the flash points for both materials were reported to be greater than 220°C. Since the AIT is always greater than the flash point, the AIT for both lubricant samples would be significantly greater than 220°C at atmospheric conditions. The AIT test was conducted using the modified ASTM E 659 method in a high-pressure reactor. The AIT for both lubricant samples was determined to be less than 195°C at 2500 psig. This study suggests that the AIT decreases with an increase in pressure.

How Chilworth Global Can Help With Your High Temperature and Pressure Flammability Testing

Chilworth Global has extensive laboratory testing facilities and expertise to conduct all of the standardized gas and vapor flammability tests which are required to develop a Material Safety Data Sheet (MSDS) and process safety programs for specific processes. Additionally, we are well positioned to conduct flammability tests under actual process conditions. Our testing and research facilities include four "barricade cells" for the testing of materials under various temperature and pressure conditions. The "barricade cells" are designed to withstand explosions of 10-lbs TNT equivalent and have the capability to monitor the system control parameters from a separate control room. Blast and missile resistant windows allow direct observation of the experiments.



High Pressure and Temperature Flammability Test Set-up in the Pressure Barricade Cell Area

Along with our test facilities, our wide variety of process equipment (pressure vessels of various sizes, shapes, and material of construction) and recognized experts in the field of gas and vapor flammability are present to help you minimize the risks involved in your process through specialized testing and consulting.

For further information regarding testing for the flammability properties of chemicals at elevated temperatures and pressures, please contact Anand Kenchenpur, Manager-Flammability Group at Tel:609-799-4449, Fax:609-799-5559, email: akenchenpur@chilworthglobal.com. You may also visit our website at: www.chilworthglobal.com.