Extinguishing Systems
For Critical Infrastructures
Building Technologies
Contents

✓ Basics of Fire
✓ Understand the Concept of Gas Based Fire Suppression System
✓ What is Clean Agent ?
✓ What are types of Clean Agents ( Gas )
✓ What is HFC 227 Gas ?
✓ What is NOVEC 1230 Gas ?
✓ Design basis of Gas System
Basics of Fire, Classifications & Concepts
What is Fire?

3 Elements of Fire

- Oxygen
- Heat
- Combustible
Fire Protection Concept

Detecting → Alarming → Extinguishing
Gas Extinguishing Systems are must to Extinguish a Fire at an early stage to avoid more damage or shut down costs.

Early activation of the Gas extinguishing system is a must!!!
Basic Extinguishing Principles

Eliminating the HEAT → WATER

Eliminating the OXYGEN → GAS

Eliminating the COMBUSTIBLE
Various Fire Protection Concept

- Building Protection
- Enclosure Protection
- Cabinet & Object Protection
Gas Based Fire Extinguishing Systems

Basics of fire Extinguishing systems

and

Overview of clean Agent systems
Clean Agent (Gas) Systems
What is Clean Agent?

The gases which are used in the fire extinguishing / suppression applications does not leave any residue over the room / equipment it just evaporates immediately after the discharge.
Types of Clean Agent Systems

Types of Clean Agents
as per NFPA 2001 Standards

Chemical Gases
(Liquid Gases)
- HFC-227ea
  (FM 200)
- FK-5-1-12
  (NOVEC 1230)
- HCFC Blend A
  (NAF SIII)
- HFC-125
  (NAF S125)

Inert Gases
(Gaseous)
- IG-01
  (Agon)
- IG-55
  (Argonite)
- IG-100
  (Nitrogen)
- IG-541
  (Inergen)
Commonly used Gas Systems

Gas Extinguishing Systems

Chemical Gases

- HFC 227ea
  25/42 Bar System

- NOVEC 1230
  25/42 Bar System

Inert Gases

- Argon : IG-01
  200 / 300 Bar System

- Nitrogen: IG100
  200 / 300 Bar System

- Inergen: IG 541
  300 Bar System
HFC 227 Extinguishing System

HFC 227ea

Basic Product & System

Information’s
HFC 227ea Extinguishing Agent

HFC 227ea - Heptafluoropropane (C₃F₇H)
Environmental Parameters - HFC227

<table>
<thead>
<tr>
<th>Agent</th>
<th>ODP</th>
<th>GWP</th>
<th>ALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFC 227</td>
<td>0</td>
<td>3350</td>
<td>29Yrs</td>
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</table>

**ODP -** Ozone Depletion Potential

**GWP -** Global Warming Potential

**ALT -** Atmospheric Life Time
Fire Extinguishing Principles of HFC227

Two basic cooling effects:

1. Direct Cooling of the flame
   - Reduction of heat by heat absorption

2. Indirect Cooling effect
   - Reduction of Oxygen

This is common for all clean agents
Sinorix 227 Working Pressure

System Working Pressure 42 Bar
High Pressure Technologies

- Fast and total evaporation of the agent during discharge
- Perfect homogenization in the room
- Average extinguishing time: 15 seconds
- Reduced damage to high value equipment
- Less shut down costs due to operational loss
- No risk of developing of by-products after extinguishing
Nozzle Pressure

Reducing the effective extinguishing time compared to conventional low pressure systems by up to 50% by only using basic physical effects given at a minimum nozzle pressure of 10 bar.

Better evaporation
# Comparison of High & Low Pressure

<table>
<thead>
<tr>
<th>Description</th>
<th>High Pressure system</th>
<th>Low Pressure System</th>
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<tbody>
<tr>
<td>Pressure at Nozzle</td>
<td>10 Bar</td>
<td>6 bar</td>
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<td>Nozzle Coverage</td>
<td>30M2 – 50M2</td>
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<td>Extinguishing time</td>
<td>&lt;15 s</td>
<td>&gt; 15 s</td>
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<tr>
<td>Pipe Size</td>
<td>Smaller</td>
<td>Larger</td>
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<tr>
<td>Pipe Length</td>
<td>Longer</td>
<td>Shorter</td>
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</table>
Extinguishing Behavior of HFC 227

- Best suited for all class of Fires
- Very fast extinguishing
- Discharge time: <10s
- Extinguishing time: 10s – 15s
- Low temperature reduction during discharge
- Electronically non conductive
- Excellent use to protect electronic risks
Toxicology of the HFC 227

- Non toxic effect if released into protected area
- Chemically inert and clean
- No residues after discharge due to complete evaporation
- No interaction with installed equipment
Design Concentration of Sinorix227

As per NFPA 2001:

1. Class A&C fire – 7.0 Vol %
2. Class B fire – 8.7 Vol %

Basic Gas Quantity:

\[ W = \frac{V}{s} \left\{ \frac{C}{100-C} \right\} \]
### Table A.5.5.1(j) HFC-227ea Total Flooding Quantity (SI Units)*

<table>
<thead>
<tr>
<th>Temp (°C)*</th>
<th>Specific Vapor Volume (m³/kg)*</th>
<th>Weight Requirements of Hazard Volume, W/V (kg/m³)b</th>
<th>Design Concentration (%) per Volume</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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</table>

*The manufacturer’s listing specifies the temperature range for operation.

\[ W = \frac{V}{s} \left( \frac{C}{100-C} \right) \]

*\( W \) [agent weight requirements (kg/m³)] = kilograms of agent per cubic meter of protected volume to produce indicated concentration at temperature specified.

\( s \) [temperature (°C)] = design temperature in the hazard area.

\( s \) [specific volume (m³/kg)] = specific volume of HFC-227ea vapor can be approximated by \( s = 0.1269 + 0.0005t \), where \( t \) = temperature (°C).

\( C \) [concentration (%)] = volumetric concentration of HFC-227ea in air at the temperature indicated.
Toxicology of the HFC 227

- Low concentration:
  - Forming HF and danger to human and equipments

- Higher concentration:
  - NOAEL: 9.0 Vol %
  - LOAEL: 10.5 Vol %
  - NOAEL- No Observed Adverse Effect Level
  - LOAEL – Lowest Observable Adverse Effect Level

- Caution: Proper design is necessary
Applications

- Computer Rooms
- Data Centers
- Server Rooms
- Telecommunication Rooms
- Switch Rooms
- UPS Rooms
- Control Rooms
- Tape Storage Rooms
Approvals of Sinorix 227

- **VdS, Germany**
  - System Approval
  - Hardware
  - Flow calculation software

- **CNPP / APSAD**

- **Hong Kong FSD and China**

- **National approvals in Europe & Asia Pacific**
NOVEC 1230 – quick, safe, and environmentally friendly

Keep fire virtual. With intelligent extinguishing solutions from Siemens.
NOVEC1230 Extinguishing agent

✓ Chemical Structure and Specifications

- Molecular weight: 316.04
- Boiling point at 1 bar: 49.0°C
- Liquid – In atmospheric condition
- Liquid density: 1.600 kg / m³ @ 25°C
- Vapour pressure at 25°C: 0.4 bar

FK-5-1-12
CF₃CF₂C(O)CF(CF₃)₂
C₆ Fluoroketone
Manufacturer – NOVEC 1230

Introduced in the year 2003
# Environmental Parameters for NOVEC 1230

<table>
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<tr>
<th>Agent</th>
<th>ODP</th>
<th>GWP</th>
<th>ALT</th>
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<tbody>
<tr>
<td>NOVEC 1230</td>
<td>0</td>
<td>&lt; 1</td>
<td>5 Days</td>
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</table>
Advantages of NOVEC 1230

- Highly effective at extinguishing fires
- Safe for valuable assets
- Safe for People
- Zero Ozone depletion potential
- Very short atmospheric lifetime
- Negligible global warming
- Accepted and Preferred around the world
### Environmental / Toxic effect

<table>
<thead>
<tr>
<th>Extinguishing agent</th>
<th>ODP</th>
<th>GWP</th>
<th>ALT</th>
<th>NOAEL</th>
<th>LOAEL</th>
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<tbody>
<tr>
<td></td>
<td>Ozone depletion potential</td>
<td>Global warming potential</td>
<td>Atmospheric Life time</td>
<td>No Adverse Effect Level</td>
<td>Low Adverse Effect Level</td>
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<td>43% N₂</td>
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<td>&lt;=1</td>
<td>5 days</td>
<td>10%</td>
<td>&gt; 10%</td>
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</tbody>
</table>
Two basic cooling effects:

1. Direct Cooling of the flame
   - Reduction of heat by heat absorption

2. Indirect Cooling effect
   - Reduction of Oxygen

This is common for all clean agents
Sinorix 1230 Working Pressure

System Working Pressure 42 Bar
Cylinder filling with chemical agent

42 bar storage HFC227 and NOVEC1230 – Same system hardware
25 bar storage HFC 227 and NOVEC1230 – Same system hardware

Vapor

HFC 227 liquid (Vapor pressure 4 bar)

NOVEC1230 liquid (Vapor pressure 0.4 bar)

Nitrogen dissolved

Nitrogen 42/25 bar
High Nozzle Pressure

- Is reducing the effective extinguishing time compared to conventional low pressure systems by up to 50% by only using basic physical effects given at a minimum nozzle pressure.

![Diagram showing Better evaporation with high nozzle pressures](image)

- 6.4 bar – RV
- 8.25 bar – CV & FV
- 4 bar air

Better evaporation
NOVEC 1230 High Pressure Technology

High pressure technology: Increased application flexibility

High pressure system
42 bar / N2

Low pressure system
25 bar / N2

Advantage of High Pressure System
- Larger system
- Smaller pipe dimension
- Lower installation cost
Extinguishing Behavior of Novec 1230

- Best suited for all class of Fires
- Very fast extinguishing
- Discharge time: <10s
- Extinguishing time: 10s – 15s
- Low temperature reduction during discharge
- Electronically non conductive
- Excellent use to protect electronic risks
Design Concentration of NOVEC 1230

As per NFPA 2001:

Class A&C fire: 4.7 %
Class B Fire: 5.9 %

Basic Gas Quantity:

$$W = \frac{V}{C} \left\{ \frac{100-C}{s} \right\}$$
Table A.5.5.1(b) FK-5-1-12 Total Flooding Quantity (SI Units)*

<table>
<thead>
<tr>
<th>Temp (°C)</th>
<th>Specific Vapor Volume (m³/kg)*</th>
<th>Weight Requirements of Hazard Volume, W/V (kg/m³)b</th>
<th>Design Concentration (% by Volume)c</th>
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<td>0.080115</td>
<td>0.3860</td>
<td>0.5201</td>
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<td>0.081485</td>
<td>0.3795</td>
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<td>60</td>
<td>0.082858</td>
<td>0.3733</td>
<td>0.5029</td>
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<td>65</td>
<td>0.084229</td>
<td>0.3672</td>
<td>0.4887</td>
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<td>70</td>
<td>0.085601</td>
<td>0.3613</td>
<td>0.4868</td>
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<td>75</td>
<td>0.086972</td>
<td>0.3556</td>
<td>0.4731</td>
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<tr>
<td>80</td>
<td>0.088344</td>
<td>0.3501</td>
<td>0.4616</td>
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<tr>
<td>85</td>
<td>0.089715</td>
<td>0.3447</td>
<td>0.4544</td>
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<td>90</td>
<td>0.091087</td>
<td>0.3395</td>
<td>0.4474</td>
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<tr>
<td>95</td>
<td>0.092458</td>
<td>0.3345</td>
<td>0.4407</td>
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</tbody>
</table>

*The manufacturer’s listing specifies the temperature range for operation.

bW/V [agent weight requirements (kg/m³)] = kilograms of agent required per cubic meter of protected volume to produce indicated concentration at temperature specified.

\[ W = \frac{V}{s} \left( \frac{C}{100 - C} \right) \]

d\[ t \] [temperature (°C)] = design temperature in the hazard area.

d\[ s \] [specific volume (m³/kg)] = specific volume of FK-5-1-12 vapor can be approximated by \( s = 0.0664 + 0.0002741t \), where \( t \) is the temperature (°C)

d\[ C \] [concentration (%)] = volumetric concentration of FK-5-1-12 in air at the temperature indicated.
Toxicology of the NOVEC 1230

- NOAEL : 10 Vol %
- LOAEL : >10 Vol %
Design Concentration of NOVEC 1230

As per NFPA 2001:

Class A&C fire: 4.7 %
Class B Fire: 5.9 %

Basic Gas Quantity:

\[ W = \frac{V}{s} \left\{ \frac{C}{100-C} \right\} \]
Applications

- Computer Rooms
- Data Centers
- Server Rooms
- Telecommunication
- Switch Rooms
- UPS Rooms
- Control Rooms
- Tape Storage Rooms

- Cell Sites
- Museum
- Science Labs
- Flammable Liquid Storage
- Archives
- Pharmaceutical
- Healthcare
## Cylinder Capacity Available

<table>
<thead>
<tr>
<th>HFC227 and NOVEC1230</th>
</tr>
</thead>
<tbody>
<tr>
<td>34 Ltrs</td>
</tr>
<tr>
<td>47.6 Ltrs</td>
</tr>
<tr>
<td>67.5 Ltrs</td>
</tr>
<tr>
<td>80 Ltrs</td>
</tr>
<tr>
<td>100 Ltrs</td>
</tr>
<tr>
<td>120 Ltrs</td>
</tr>
<tr>
<td>140 Ltrs (Selective)</td>
</tr>
</tbody>
</table>

- All Cylinders shall be Seamless and PESO (CCoE) Approved
## Comparison – HFC227 & NOVEC 1230

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HFC 227</th>
<th>NOVEC 1230</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>GWP</td>
<td>3350</td>
<td>1</td>
</tr>
<tr>
<td>ALT</td>
<td>29 Years</td>
<td>5 Days</td>
</tr>
<tr>
<td>NOAEL</td>
<td>9.0 %</td>
<td>10.0%</td>
</tr>
<tr>
<td>LOAEL</td>
<td>&gt; 10.5 %</td>
<td>&gt; 10.0 %</td>
</tr>
<tr>
<td>Design Concentration</td>
<td>7.0 %</td>
<td>4.5 % to 4.7 %</td>
</tr>
<tr>
<td>Flooding Factor</td>
<td>0.5486 Kg/M3</td>
<td>0.6531 to 0.684 Kg/M3</td>
</tr>
<tr>
<td>Gas Qty for 1000 M3</td>
<td>548.6 Kgs</td>
<td>684.0 Kgs</td>
</tr>
<tr>
<td>No. of 120 L cylinder</td>
<td>6 or 7</td>
<td>8 or 9</td>
</tr>
</tbody>
</table>
## Comparison of VdS, LPCB (BRE), UL & FM

<table>
<thead>
<tr>
<th>Content</th>
<th>CE</th>
<th>VdS</th>
<th>LPCB (BRE)</th>
<th>UL</th>
<th>FM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area</strong></td>
<td></td>
<td>No.1 in Europe</td>
<td>UK fire &amp; security certification (Notified body)</td>
<td>Biggest product security test &amp; certification institute in US, mainly focus on civilian industry product</td>
<td>Biggest underwriter in US, not official certification body (insurance C0), focus on industrial product</td>
</tr>
<tr>
<td><strong>Voluntary/ Compulsory</strong></td>
<td></td>
<td>Voluntary</td>
<td>Voluntary</td>
<td>Compulsory</td>
<td>Voluntary, but must get FM certification to buy FM insurance</td>
</tr>
<tr>
<td><strong>Market (mainly)</strong></td>
<td></td>
<td>Europe</td>
<td>Europe</td>
<td>America</td>
<td>America</td>
</tr>
<tr>
<td><strong>Requirement</strong></td>
<td></td>
<td>EN, almost harmonized with ISO, IEC</td>
<td>VdS, EN, IEC, ISO etc., VdS standards are higher than CE</td>
<td>BS,EN,ISO</td>
<td>UL &amp; NFPA standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FM, certain relationship with UL&amp;NFPA standard, requirement is less than UL</td>
</tr>
</tbody>
</table>
## Comparison

<table>
<thead>
<tr>
<th>Chemical Gases:</th>
<th>Inert Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid discharge</td>
<td>Longer discharge time</td>
</tr>
<tr>
<td>Low extinguishing concentration</td>
<td>High extinguishing concentration</td>
</tr>
<tr>
<td>Less gas quantity</td>
<td>More gas quantity</td>
</tr>
<tr>
<td>Lesser cylinder storage space</td>
<td>More cylinder storage space</td>
</tr>
<tr>
<td>Lower working pressure</td>
<td>Very high working pressure</td>
</tr>
<tr>
<td>Formation by products</td>
<td>No formation of by products</td>
</tr>
<tr>
<td>Shorter Pipe network</td>
<td>Longer Pipe network</td>
</tr>
</tbody>
</table>
Further Connect

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Fire Suppression Systems
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Stay Connected
Thank you