



Fire Protection Training

Procedures Handbook 4300

FIRE PHYSICS & CHEMISTRY

TOPIC: Products of Combustion

TIME FRAME: 1 Hour

LEVEL OF INSTRUCTION:

BEHAVIORAL OBJECTIVE:

Condition: A written quiz

Behavior: Student will identify the products of combustion, hazards and exposure routes of toxics

Standard: With a minimum 70% accuracy

MATERIALS NEEDED:

- Chalkboard
- Chalk
- Appropriate visual aids
- Audio visual equipment

REFERENCES:

- IFSTA, Essentials of Firefighting, 2nd Edition, Chapter 1
- NFPA, Principles of Fire Protection Chemistry
- NFPA, Fire Protection Handbook, 17th Edition

PREPARATION:

Exposure to the products of combustion presents numerous hazards to humans. Recognizing these hazards and their effect on the human body is necessary for firefighter safety.



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PRODUCTS OF COMBUSTION

PRESENTATION	APPLICATION
<p>I. PRODUCTS OF COMBUSTION</p> <p>A. When a Fuel Combusts, Molecules Break Down and Combine with Oxygen Forming Totally Different Compounds while Simultaneously Releasing Stored Energy.</p> <ol style="list-style-type: none"> 1. The matter contained in the fuel is neither created or destroyed, it only changes form. 2. These new compounds are the physical products of combustion. <ol style="list-style-type: none"> a. Smoke b. Fire gases c. Ash <p>B. The Energy Released during Combustion Takes Two Forms.</p> <ol style="list-style-type: none"> 1. Light (flame) 2. Heat <p>II. PHYSICAL PRODUCTS OF COMBUSTION</p> <p>A. Smoke</p> <ol style="list-style-type: none"> 1. Visible 	<p>Methane Oxygen $CH_4 + 2O_2$ changes to:</p> <p>Carbon Water Dioxide Vapor $CO_2 + 2H_2O$</p> <p>What are the two forms of energy released during combustion?</p>



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<ul style="list-style-type: none">2. Consists of finely divided particulate matter and suspended liquid droplets.3. Formed due to incomplete combustion.<ul style="list-style-type: none">a. Flammable liquids and other fuels produce very dark smoke indicative of incomplete combustion.4. Hazards<ul style="list-style-type: none">a. Limits visibilityb. Particulates are harmful when inhaled<ul style="list-style-type: none">(1) Contain residue of toxic fire gases <p>B. Fire Gases</p> <ul style="list-style-type: none">1. Usually colorless/not visible2. Classes of fire gases<ul style="list-style-type: none">a. Toxicantsb. Asphyxiantsc. Irritants3. Toxicants<ul style="list-style-type: none">a. Poison gases<ul style="list-style-type: none">(1) Central nervous system(2) Cardio-pulmonary systemb. Examples<ul style="list-style-type: none">(1) Carbon monoxide	<p>What are the hazards of smoke?</p>



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<ul style="list-style-type: none">(a) Produced by incomplete combustion of many fuels.(2) Hydrogen cyanide<ul style="list-style-type: none">(a) Produced by burning materials containing nitrogen. (Wool, silk, nylon, etc.)(3) Sulfur dioxide(4) Nitrogen oxides(5) Many others depending on material burning. <p>4. Asphyxiants</p> <ul style="list-style-type: none">a. May also be toxicb. Displace oxygen causing an oxygen deficient environment.c. Example:<ul style="list-style-type: none">(1) Carbon dioxide <p>5. Irritants</p> <ul style="list-style-type: none">a. May also be toxicb. Sensory<ul style="list-style-type: none">(1) Eyes(2) Nosec. Pulmonary<ul style="list-style-type: none">(1) Lungs and breathing passagesd. Examples:	



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<p>(1) Hydrogen Chloride</p> <p>(a) Formed by combustion of chlorine containing materials. Most notably P.V.C.</p> <p>(2) Acrolein</p> <p>(a) Formed by smoldering cellulosic materials.</p> <p>C. Ash</p> <ol style="list-style-type: none">1. Ash is the non-combustible residue remaining after a solid fuel is consumed.2. Ash can be toxic itself or contain trace amounts of toxic fire gases.	
<p>III. ENERGY</p> <p>A. Light (Flame)</p> <ol style="list-style-type: none">1. Most of the chemical reactions of combustion take place within what we see as flame.2. The flame produces light.<ol style="list-style-type: none">a. The amount of light is dependent on the chemical make up of the fuel. <p>(1) Fuels like hydrogen and alcohol produce less light.</p> <p>(2) Fuels like gasoline and others containing large amounts of carbon produce more light.</p>	<p>What fuels produce flames with limited light and color?</p>



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<p>contents of the atmosphere prevent this.</p> <ul style="list-style-type: none"> b. Burn injuries <ul style="list-style-type: none"> (1) Destruction of skin cells/layers c. Respiratory tract injuries <ul style="list-style-type: none"> (1) Decline in blood pressure (2) Capillary vessel collapse (3) Fluid buildup in lungs d. Hyperthermia <ul style="list-style-type: none"> (1) Body temperature is elevated substantially above normal (2) Can occur without burns 	<p>What is hyperthermia?</p>
<p>IV. TOXIC EXPOSURE ROUTES</p> <ul style="list-style-type: none"> A. Inhalation <ul style="list-style-type: none"> 1. Breathing passages and lungs B. Ingestion <ul style="list-style-type: none"> 1. Hand touching mouth C. Absorption <ul style="list-style-type: none"> 1. Skin contact 2. Turnouts provide very limited protection from fire gases. 	<p>What are the toxic exposure routes?</p>



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<p>D. Injection</p> <ol style="list-style-type: none">1. Most commonly through injuries that break skin.	



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PRODUCTS OF COMBUSTION

SUMMARY:

All the products of combustion have the ability to injure or kill fire suppression personnel. Recognizing these hazards and knowing how they affect the human body will allow you to take the proper measures to insure your safety.

EVALUATION:

A written quiz.

ASSIGNMENT:

To be determined by the instructor(s).