Incendiary Chemical and LED Flare Comparison

Appearance

Economics

a. Setting the Stage

Assume a homeowner puts out a six (6) flare display every July 3rd.

Assume further that chemical flares cost the homeowner $3-4 each.

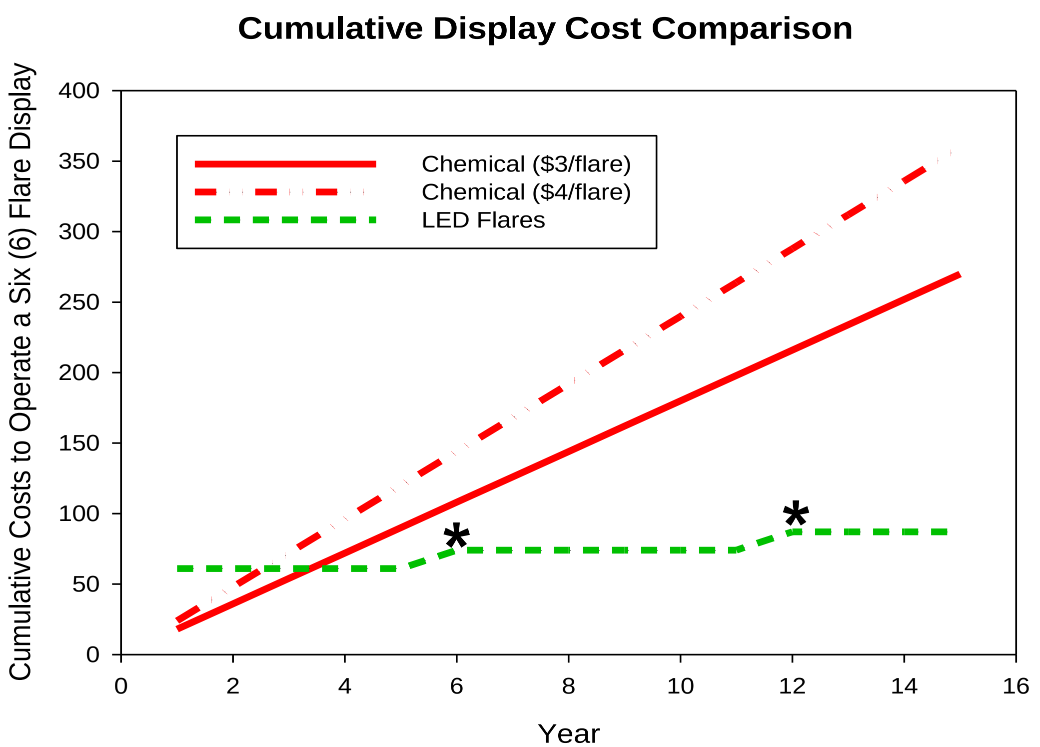
Amazon sells LED flare six (6) packs for $44 + tax ($48 total).

LED flares require three (3) AAA batteries each (18 batteries for 6 LED flares).

Duracell AAA batteries are available on Amazon for $0.67 each + tax ($13 for 18).

b. Costs Over Time

The following graph illustrates the cumulative costs to a homeowner for putting on a six (6) flare display every July 3rd over a 15 year period of time.



The * indicate when all the AAA batteries are replaced every six (6) years. (Note: Some Silver Lake residents have used the same AAA batteries in their LED flares for at least seven (7) years. LED flare users at other lakes report more than 10 years of use from a single battery set.)

c. Analysis / Interpretation

For a six (6) flare display:

The initial capital outlay is greater for LED flares in comparison to chemical flares.

Chemical flare-based displays are less expensive to put on in comparison to LED-based flare displays for the first 3-4 years.

After the initial 3-4 year period, the cumulative cost to the homeowner to put on a display with six (6) chemical flares significantly exceeds the cost to for the same homeowner to put on a six (6) flare LED-based display.

Over the long-term LED flares are always a more economical option in comparison to chemical flares.

Finally, the LED operating lifetime is up to 10,000 hours, greatly exceeding the number of July 3rds we as humans could ever hope to see during our own lifetimes.

Environmental Impact

a. Chemical Flare Composition

The materials safety data sheet (MSDS) from the flare manufacturer (Orion) lists the following chemicals in the chemical flares that the SLA buys, sells:$^{+}$

Strontium nitrate ($Sr(NO_3)_2$)
Potassium nitrate (KNO_3)
Potassium chlorate ($KClO_3$)
Sulfur (S)
Charcoal (C)
Paraffinic oil (C_nH_{2n+2})
Sawdust (cellulose, $(C_6H_{10}O_5)_n$)
Polyvinylchloride (PVC, $(C_2H_3Cl)_n$)
(+) The exact composition is a trade secret

b. Chemical Flare Burning

When chemical flares burn they produce a bright red emission (from excited-state strontium ions) and smoke.

The chemical flare manufacturer's MSDS states: "Inhalation of smoke from burning flares will cause irritation to the lungs and mucus membrane."

Amongst the products in the flare debris and flare smoke are the following:

Strontium oxide (SrO, solid)
Potassium oxide (K_2O, solid)
Nitrogen (N_2)
Oxygen (O_2)
Carbon dioxide (CO_2)
Water vapor (H_2O)
Sulfur dioxide (SO_2)
Hydrogen chloride (HCl)
Nitrogen dioxide (NO_2)

c. Debris and 'Smoke'

- Strontium and potassium oxide (SrO and K_2O) are solids. If picked up promptly, they present minimal environmental impact. However, both of these oxides are soluble in water forming strontium hydroxide ($Sr(OH)_2$) and potassium hydroxide (KOH), respectively. The compounds make the water more alkaline.

- Nitrogen (N_2) and oxygen (O_2) gasses are the two primary chemical compounds in the air we breathe on this planet (78% and 21%, respectively). These chemicals present no significant environmental impact.

- Carbon dioxide (CO_2) is a well-known greenhouse gas.

- Water (H_2O) is the second most important chemical compound on earth. At first blush, water seems innocuous, but there is much more as seen with the Sr and K oxides (discussed above) and the reaction with other gasses (as discussed below).

- Hydrogen chloride (HCl). This compound reacts quickly with water to form hydrochloric acid (HCl) (see below).

- Nitrogen dioxide (NO_2) is a pungent gas that, along with fine airborne particulate matter, contributes to the reddish-brown haze characteristic of smoggy air. There is more (see below).

d. More…

Hydrochloric acid (HCl) has numerous negative environmental impacts, including:

Acidification: HCl can acidify water and soil, which can damage ecosystems. And, because the flare smoke contains water vapor (H_2O), the acid formation process is greatly accelerated.

Acid rain: HCl can be a component of acid rain.

Plant damage: HCl is a phytotoxicant and can damage plants.

Non-precipitating clouds: HCl may travel in non-precipitating clouds and reach distant ecosystems.

HCl is also corrosive to most metals and can irritate the membranes of the eye and upper respiratory tract. Prolonged exposure to low concentrations can cause tooth erosion, and severe exposure can result in fatal pulmonary edema and laryngeal spasm.

Nitrogen dioxide (NO_2). When nitrogen dioxide is present in the air it forms secondary pollutants like ozone (O_3), nitric acid (HNO_3), and nitrate particles (see below), contributing significantly to smog formation and acid rain.

Nitrates are essential plant nutrients, but in excess amounts they can cause significant water quality problems. Together with phosphorus, nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of aquatic plants. This, in turn, affects dissolved oxygen, temperature, and other indicators in freshwater lakes.

The Big Picture

Incendiary flares produce chemicals that negatively impact humans, plants, and water bodies. Amongst the by-products are excess nutrients that contribute to well-known problems in water bodies.

SLA members, the SLAWQ team, and CLEAN@Silver Lake have been battling excess nutrients (phosphorous and nitrogen based) flowing into Silver Lake for years.

LED flares provide a way to enjoy July 3rd activities at Silver Lake while lowering excess nutrient production.

Over the long-term, LED flares are clearly a more inexpensive option in comparison to incendiary flares.