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Website Article: **No. 1304**

Date: May 2014
Words: 1,252
Rights: First Serial
Photos/Illus: 8
Article price: Open
Placement: Website
Category: Science/History

BOTTLE IRRADIATION

(Altering glass bottle)

(before irradiation) **(after irradiation)**

(Fig 1) **Contoured "Hobble-Skirt" *Coca-Cola bottle,* "PAT. DEC.1923" ('Xmas Coke')**

Researched, illuminated, and presented

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Introduction

In recent years the practice of altering the color of glass bottles, insulators and other collectible glass objects has become widespread and is an increasingly confusing and damaging aspect of antique bottle collecting, insulator collecting, and other areas of glassware collecting.

There are two sources known for intentionally altering the integral color of glass: *thermal* and *radiation.* Both can create color changes from very subtle to extremely radical: (1) Thermal alteration, as the term implies, are achieved by the use of extreme heat: (2) Alteration performed by use of radiation sources are much more complex and include high level of *gamma rays* and *electron beams.* Most common – in the use of radiation – as well as problematic is the common use of isotopes that normally send germ-killing **X-rays**, **Cobalt-60**, or **Cesium-137** gamma rays through food to kill microorganisms. This process of ***irradiation*** to change the color of glass is often called **"nuking"** and has been rapidly increasing in use in recent years.

There are several methods of irradiating glass: (1) one method is in using hospital-sterilizing equipment; (2) another method involves running glass objects through a sterilizing chamber such as used at meat processing facilities; (3) there is still another source of irradiation that is achieved through the use of pure gamma sources. Using such ionized radiation leaves no contamination and the items "nuked" are not radioactive. The results most often appear to be the same – either dark purple or mud brown depending upon the chemicals originally included in the glass batch itself.

It should be noted that the color alterations that are discussed here **are not** achieved by external application of paint, stains, or dyes but rather they are more technical modification to the internal ingredients of glass itself. Such color changes vary from very subtle to extremely radical such as shown in the illustration of the world's most famous bottle [(the *Coca-Cola* contoured bottle) first created in 1914] featured on the cover of this article (**Fig. 1**).

(Fig 1) Contoured "Hobble-Skirt" *Coca-Cola bottle,* "PAT. DEC.1923" ('Xmas Coke')

Glass content

The primary ingredients for making common raw glass are: (1) silica sand, (2) soda ash, and (3) limestone. Iron is almost always present in silica sand, providing a light to medium blue green color to raw glass. Raw glass was customarily referred to in the glass making industry as "*green glass"* because of iron-induced color. Within glass collecting the same "green glass" color is now generally referred to as "aqua".

Glass colors

"For thousands of years most cheap glass used in the manufacture of bottles and other common glass objects were produced in aqua color because the iron in the raw materials, mostly in the sand. Glassmakers did know, however, that pure ingredients would produce clear glass; in many cases where clear glass was demanded attempts were made to purify the raw ingredients. Glassmakers went so far as to crush iron-free quartz crystals to obtain pure silica….

"Glass can be produced in all colors of the spectrum. Early glassmakers knew this could be accomplished by adding certain compounds to the basic glass mixture. The following table shows some of the kinds of materials (mostly oxides) frequently used and the colors obtained":

copper, selenium, **gold**	reds
nickel or manganese	purples
chromium or copper	greens
cobalt	blues
carbon or nickel	amber/brown
iron	greens, browns, yellows
selenium	yellows, pinks
tin	opal, white
iron slag	black

The Illustrated Guide to COLLECTING BOTTLES
by Cecil Munsey, PhD
New York, Hawthorn Books, Inc.
1970 (Chapter 7, page 37)

Some of the compounds utilized in determining resulting colors are expensive oxides. For example in early days it took one ounce of gold to create sixty pounds of ruby-red glass. (Since the 1930s, red-colored glass is achieved by utilizing iron oxide and reheating the batch during initial manufacture.)

Compounds used in various combinations produce a wide range of colors as described in the previous list (above).

A number of variables can affect the actual color produced, including the amount of the compounds used, the degree to which the basic glass mixture is impure, the temperature and time-temperature relationship, and reheating necessary to complete the piece of glass."

"Natural" color transformation

The technique of adding small amounts of manganese to a glass mixture to produce clear glass had been known but hardly bothered with since its discovery before the time of Christ.

From around **1880**, when the public demand for clear glass forced the manufacturers to perfect the technique of decolorizing; manganese was used, until approximately **1915**, at which time World War I cut off the main source (Germany), manganese was America's most widely used decolorizing agent. By **1916** glassmakers were forced to use the more stable but also more expensive decolorizing agent, selenium.

Both manganese and selenium oxides act as neutralizing agents, masking the light green and blue ("aqua") caused by the inherent impurities in the raw ingredients with a complimentary color. Both of these decolorizers produce yellow, red, and purple while the iron impurities produce blue and green. The mixing of these opposite colors results in a neutral color that has the visual effect of no color at all.

The use of selenium continued until around **1930**, when arsenic became the popular decolorizer.

Unknown to, or at least disregarded by, glass manufacturers using manganese and selenium, was the fact that when decolorized glass is exposed to the ultraviolet rays (of the sun as one example) it assumes an amethyst (purple) color if it contains manganese or a light yellow color if it contains selenium. This reaction is explained by the facts that when the decolorizers were added, the ions within the substance were in a *reduced* state and when exposed to ultraviolet rays they are put into an *oxidized* state. [Of interest may be the fact that when glass with a decolorizing agent in the oxidized state is reheated, the decolorizing agent return to its original reduced state and the glass once more becomes clear.]

Glass colored by ultraviolet sunrays is commonly called '*sun-colored glass', 'purple glass' or 'desert glass'.*

The amount of color subtracted from a piece of glass depends on two variables: (1) how much of a decolorizing agent was originally used; (2) how long the glass has been exposed to ultra violet rays.

Thermal reversal of authentic colors (reversing sun-purpled glass)

It is an established certainty that light to medium sun-colored glass exposed to heat will reverse the sun's or other methods that 'have been used to purple glass'. During the thermal reversal process, the manganese is once again the key stimulant.

When a sun "purpled" bottle is heated to high temperatures, generally a step before melting, it will revert back to a shade in close proximity to its original manufactured color.

The following seven photographs (Figs. 2-7) are of bottles that have been changed from their original color by way of irradiation ["nuking"]:

(Fig. 2 . . . purple *Ball* fruit jar)

(Fig. 3 . . . amber *Ball* fruit jar)

(Fig. 4 . . . green and amber *Ball* fruit jars)

(Fig. 5 . . . light amber ***"Ball Improved"*** fruit jar)

(Fig. 6 …light amber contemporary (screw-lid) "historical" flask)

(Fig. 7 . . . purple soda water ("pop") bottle)

(Fig. 8 . . . two standard "Georgia Green" and light amber irradiated "hobble-skirt" Coca-Cola bottles)

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