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# Influence of a Radition on Technical and Operational Qualities of Gasoline

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**Abstract:** As a research object it has been used the samples of petrol AI-92 from the oil of Azerbaijan. Laboratory studies have been conducted on gamma-source $Co^{60}$ at dose rate P=0,18 Gy/s within the absorption dose range D=15-150 kGy. The results of chromatographic, IR-spectroscopic studies have been given. The viscosity and density of the samples have been determined. Concentration, radiation-chemical yields of the obtained gases at different absorption doses of the samples of petrol AI-92 have been determined and their radiation resistance has been evaluated. The methods applied to determination of radiation stability are based on radiation of a product and the subsequent determination of the changes which happened in it. Impact of radiation on operational characteristics of fuels in static conditions on a regular technique before radiation was researched. Radiation oxidations of processes considered in the field of low temperatures when chain processes don't happen. The purpose of this work is the research of radiation firmness of fuels from oils of Azerbaijan. Results of such researches allow to estimate radiation stability of fuels, to find out influence of irradiation on general composition of fuels and possible changes of qualities of fuels.

**Keywords:** Petrol, Fuel, Radiolysis IR-Spectrum, Gases

## 1. Introduction

Petrol is a mixture of hydrocarbons of various structures of $C_4$-$C_{12}$. It is flammable liquid with a density of 700-780 kg/m$^3$, poignant smell, evaporates quickly, does not dissolve in water, burns without a trace. The boiling temperature is from 30°C to 200°C. All fuels are organic compounds of different complexity and under the influence of radiation energy there occurs a change in physical and chemical properties of fuels. The influence of radiation exposure on petrol composition, establishment of the links between the requirements for petrol composition and its radiation resistivity are of practical interest. Excited molecules, radicals are formed and gases escape under ionizing radiation influence on hydrocarbons. Chemical transformations are accompanied by the changes in physical properties of fuel. While selecting fuel for being used under irradiation it is necessary to find out whether the fuel has sufficient radiation resistance, whether it is possible to increase its stability due to changes in the composition or introduction of special additives. Stability – the ability of fuel to keep its chemical structure under operating conditions within temperature changes, radiation, influence of metals. It is necessary to maintain the thermal stability of jet engine fuel for aircrafts even at low radiation doses. When it is not feasible, new types of fuels with adequate radiation resistance should be developed.

We studied several operational performance of fuel under static conditions in the usual manner before and after irradiation. The results of experimental studies of the effect of radiation on various oil products were previously conducted in the papers [1-8].

## 2. Methodology

The samples (petrol AI-92 in 2,5 ml) placed in ampoules and sealed in vacuum, were irradiated at room temperature on gamma-source $Co^{60}$ at dose rate P=0,18 Gy/s at different absorption doses: within the range of 15-150 kGy in vacuum so as to trace the kinetics of the current processes. As an ionizing radiation it was used Y-radiation source $Co^{6060}$ of type MPX Y-30.

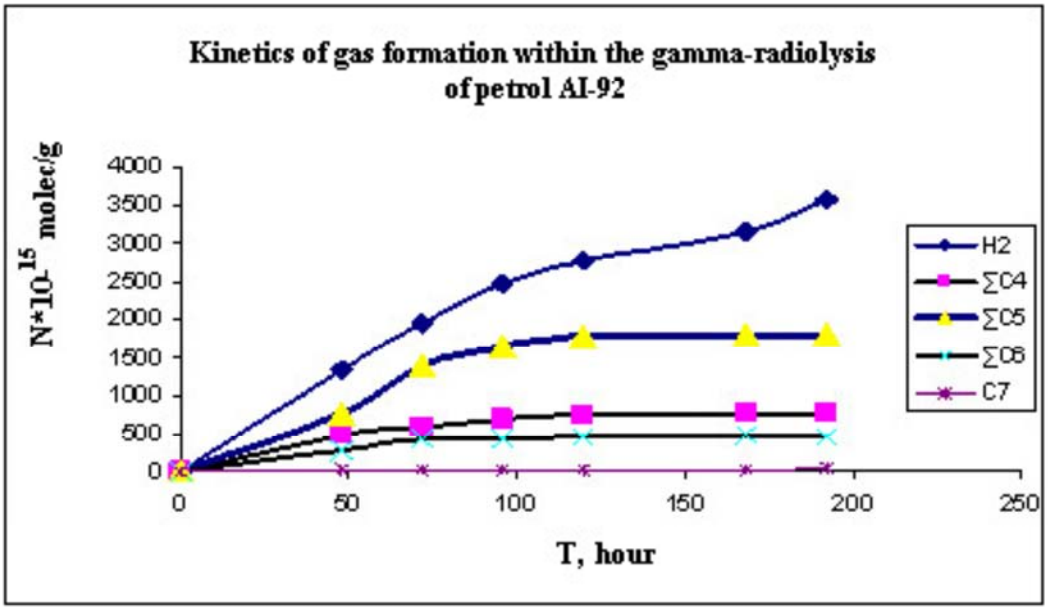
IR-absorption spectra of the studied samples were

registered on spectrometer VARIAN 640-IR (VARIAN Company) in the wavelength range (4000-400cm$^{-1}$). The samples were removed in the form of film with a thickness of d=1. Assignment of the bands of the obtained spectra was carried out as described in [9-10]. Gas products were analyzed by gas chromatography method. The density was determined by a pycnometer according to GOST 3900-85. The viscosity was determined according to GOST 33-66 by a viscometer of VPJ-2 type corresponding to GOST 10028-81.

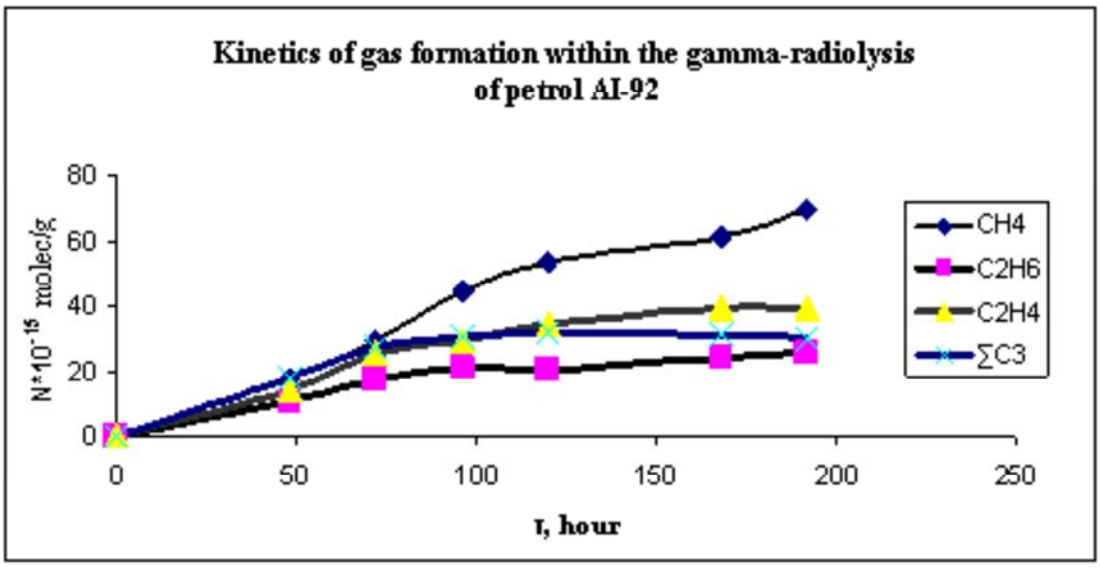
The aim of the work is the study of radiation resistance of the petrol AI-92 from Azerbaijan oil

## 3. Experiments and Results

Below are the kinetic curves of gas accumulation at gamma-radiolysis of the petrol AI-92 from Azerbaijan oil (figure 1).




(a)

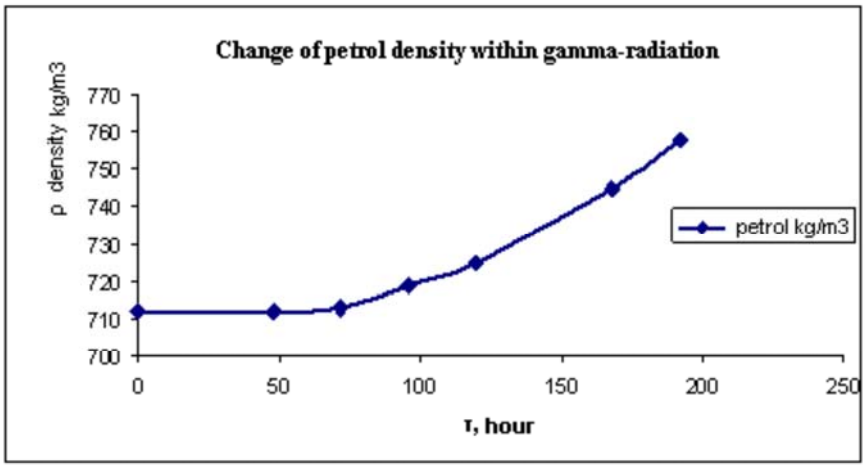



(b)

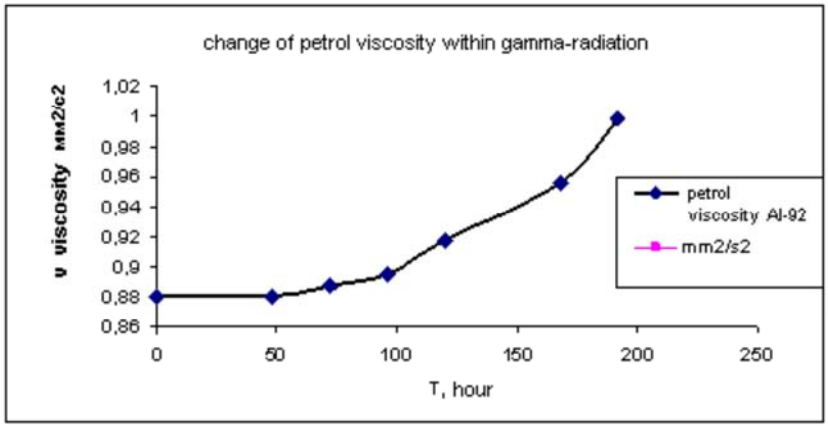
***Figure 1.*** *( a, b) Kinetic curves of gas accumulation at gamma-radiolysis of the petrol AI-92 from Azerbaijan oil.*

The changes in viscosity and density of the initial petrol and after radiation exposure at different absorption doses are given below in figure 2 (a, b).

The viscosity of the initial petrol is 0,88 cSt (mm$^2$/c$^2$). The density of the initial petrol is 710 kg/m$^3$.




(a)




(b)

***Figure 2.*** *(a, b) Changes in viscosity and density of petrol before and after radiation exposure.*

Total radiation-chemical yields of gases of petrol AI-92 within absorbed dose range of 15-150 kGy have been presented in the table 1.

***Table 1.*** *Radiation-chemical yields of gases of petrol AI-92 within absorbed dose range of 15-150 kGy.*

| *Gases* | $H_2$ | $CH_4$ | $C_2H_6$ | $C_2H_4$ | *ΣC3* | *ΣC4* | *ΣC5* | *ΣC6* | *ΣC7* |
|---|---|---|---|---|---|---|---|---|---|
| Petrol AI-92 | 0,446 | 0,0074 | 0,0040 | 0,0057 | 0,0053 | 0,132 | 0,322 | 0,091 | 0,006 |

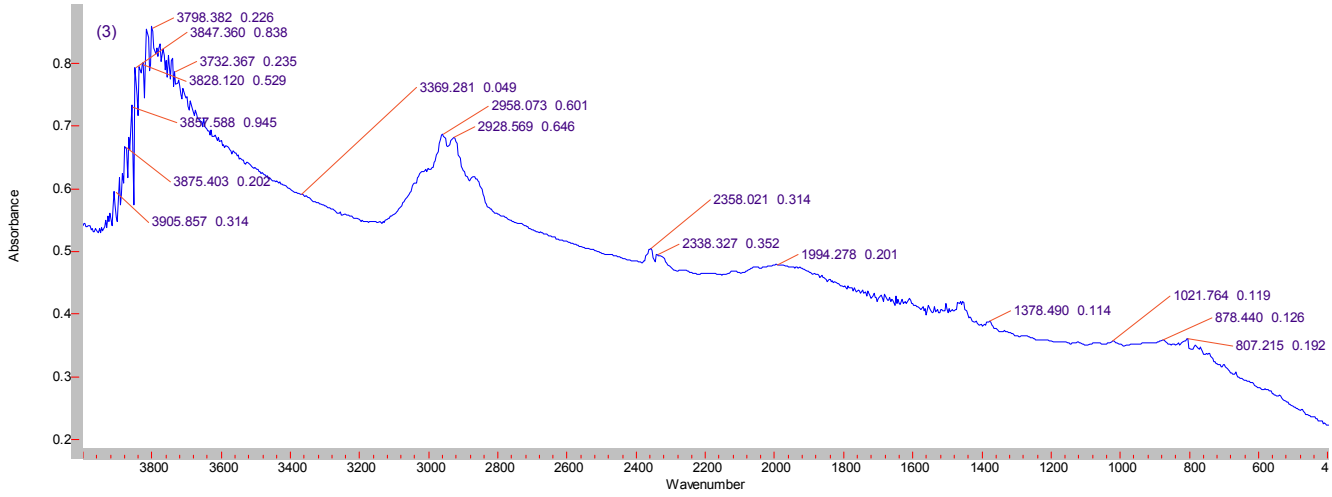
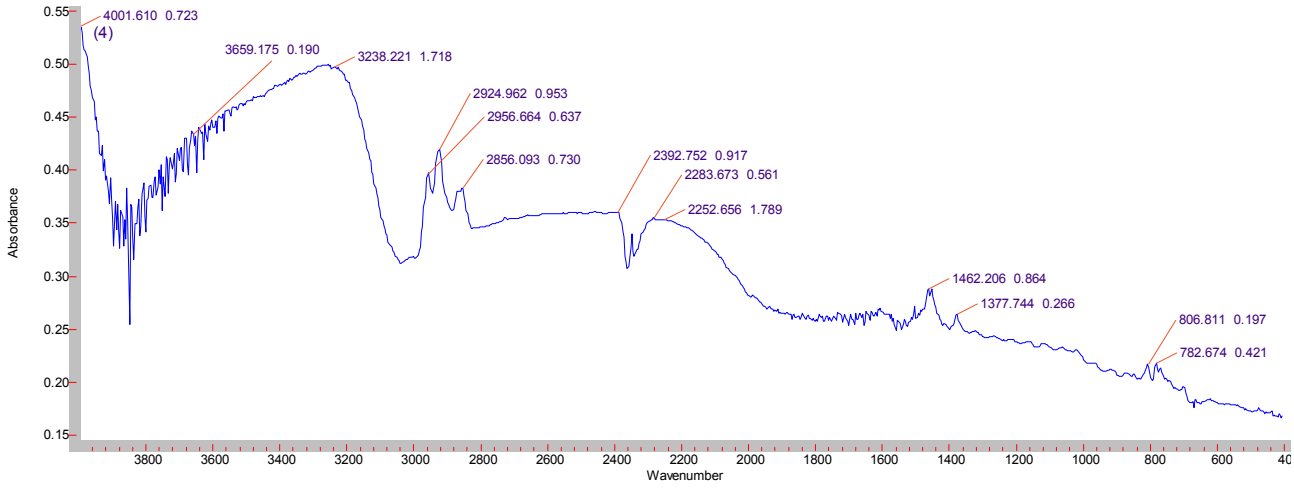
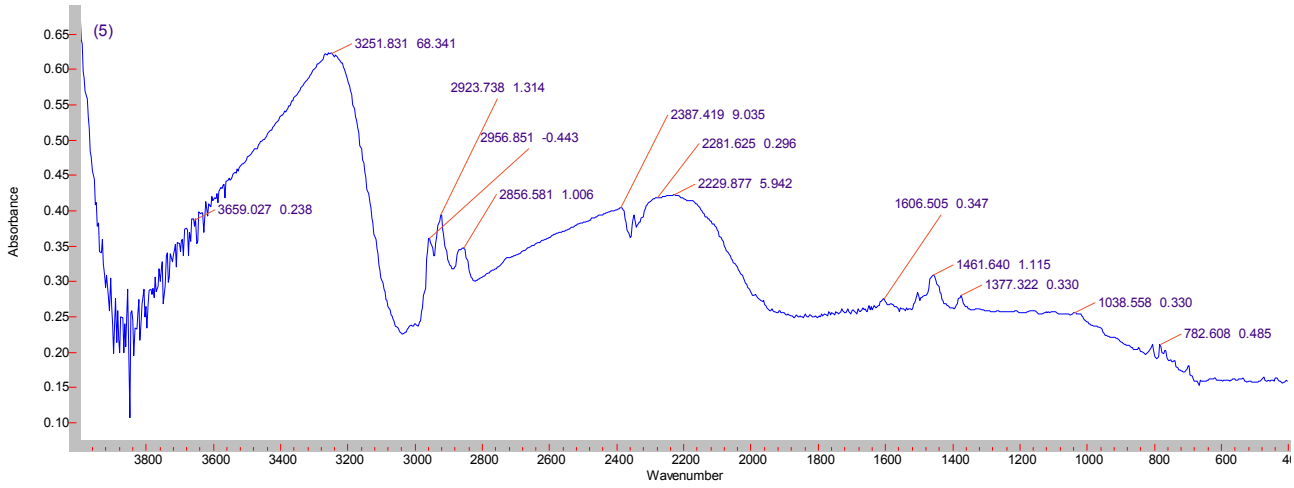



***Figure 3.*** *IR - spectra of original petrol AI-92 (without irradiation).*




(a)




(b)

***Figure 4.*** *(a, b). IR-spectra of irradiated petrol a) (120 hours irradiation), b) (240 hours irradiation).*

Out of plane deformation oscillation of C-H group in the range of 1000-650 $cm^{-1}$. After 120 hours irradiation, twice decrease in (1000-650) $cm^{-1}$- intensity of out of plane deformation oscillations C-H, as well as decrease in deformation oscillation of -$CH_3$- groups (1370-1380 $cm^{-1}$) are observed. (1440-1480) $cm^{-1}$- deformation oscillation of $CH_2$-group is formed. 2252, 2283, 2392-(2860-2960 $cm^{-1}$) - valence oscillation of $CH_3$-group and 2940-2915 $cm^{-1}$- oscillation of -$CH_2$ bonds in alkanes decrease. There appears (3200-3400) $cm^{-1}$ imines C=NH.

After 240 hours irradiation, (1600-1440) $cm^{-1}$- valence oscillation of = CH bonds is formed, 1650-1580 $cm^{-1}$ pyridines and quinolines appear, the intensity of the bands of 2300-2230$cm^{-1}$ - azo compound and (3310-3200) $cm^{-1}$- the absorption band of alkyne and triple bonds increase. Intensity of band of $CH_3$ group attached to heteroatoms (2860- 2975) $cm^{-1}$ decreases.

## 4. Discussion of the Results

At big height hydrocarbonic fuel on planes can appear under the influence of space particles of big energy. However the processes which have arisen in connection with radiolizy can develop after the radiation termination for a long time that leads to change of composition of fuel. It is especially characteristic of the oxidizing processes which are followed by formation of peroxides. It is very important to keep thermal stability of jet fuels for supersonic planes at least at small doses of radiation. Every year use of organic materials - polymers of lubricants, fuels, heat carriers under operating conditions when they are affected by ionizing radiation, in operating conditions of atomic reactors, accelerators of electrons, in the conditions of space extends. Researches have shown that organic materials are sensitive to radiative effects, real terms of service of concrete technical products depend on their ability to keep initial properties in radiation fields.

All fuels are organic compounds, therefore different radiation lead to chemical degradation and formation of new chemical structures. Study of the irradiation influence on the composition of oil fuel, establishment of link between the demand for fuel composition and its radiation resistance is of practical importance. Unstable fuel are those which have unsaturated compounds and tar. Sunlight and radiation

significantly increase the rate of tar formation in diesel oil. Within radiolysis of hydrocarbon mixtures the initial impact energy is rapidly absorbed by liquid and chemical changes occurring under radiation influence are caused by the effect of electrons with the energy less than 100 eV. As a result of γ-radiation in the irradiated medium fast electrons occur, which have high energy and are capable to change the chemical properties of molecules. In this case chemical bonds are broken and free radicals, ions are formed which have free valences and excess energy. Simultaneously with the low molecular compounds of fragmental character, dimers and polymers are formed as the products of recombination of radicals and ions as a result of cracking, dehydrogenation, isomerization and polymerization of hydrocarbons. Radiolysis of alkanes leads to some of their dehydrogenating with disengagement of free hydrogen, radicals and ions. Secondary, especially tertiary and quaternary C-C bonds and secondary C-H bonds easily burst under radiolysis influence. The yield of gaseous products, including hydrogen is reduced within the irradiation of ethylenes. Total yield of radiolysis products, in which polymers are dominant, increases. More stable ones to radiation effect are polynuclear aromatic hydrocarbons, consisting of 2-4 rings, which were the basis to recommend this class of compounds for using as hydraulic fluid and lubricants working under the conditions of relatively high temperatures and radioactive radiation influence. Such compounds showed high radiation resistance even under intense γ-radiation [11-12].

## 5. Results

Chemical processes, changes in density and viscosity occur in petrol within absorbed dose range 15-150 kGy. The effect of radiation influence on hydrocarbons of fuel depends on chemical structure, fuel composition. When the formation of radicals slow down at low temperatures, small amount of seal products are formed in hydrocarbon medium as a result of radiation. But operational performance of oil fuels deteriorate and compress sprayer even in a slight resin formation at the temperature of ambient air. In the future, it will be necessary to select such composition of oil fuel, which will withstand the effect of irradiation by changing hydrocarbon composition of oil products due to minor changes in the composition and introduction of additives.

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