Gasoline phase changes

How much water can gasoline blends absorb before a phase change occurs?

Background

Ethanol, a renewable fuel source produced from corn, has replaced methyl-tertiary-butyl-ether (MTBE) in most of the oxygenated gasolines commercially available in the United States. However, the introduction of oxygenated fuels in the US has come with some concern of potential water phase separation in the fuel product. Ethanol does readily dissolve water, and is considered infinitely soluble in water. Consequently, since ethanol and water readily dissolve in one another, this gasoline blend will dissolve water to a much greater extent than gasoline not oxygenated with ethanol.

When water reaches the maximum amount that the gasoline blend can dissolve, any additional water will separate from the gasoline blend. This is called phase separation. Phase separation results in a liquid water layer that may interfere with a combustion engine. The amount of water required for a phase separation to take place varies with both the temperature of the gasoline blend and the product used to oxygenate the gasoline.

Materials

- Gasoline blends such as: ethanol blends: U-87, U-88, non-ethanol blend: 90-0
- 30 ml test tubes
- Test tube rack
- Distilled water

Instructions

1. Discuss the differences between the fuel samples in your lab group and make a prediction below describing which fuel type will undergo a phase separation with the smallest volume of water and why.
2. Place 15 ml of room temperature fuel sample in a test tube.
3. Slowly add one drop of room temperature distilled water at a time until a phase change is observed.
   Note: one drop of water is equal to 0.05 ml.
4. Repeat for each fuel type.
5. Place 15 ml of fuel sample in a test tube and warm it to 20 degrees C above room temperature in a hot water bath. Remove from the hot water bath.
6. Slowly add one drop of room temperature distilled water at a time until a phase change is observed.
7. Repeat for each fuel type.

Prediction

Which fuel type will undergo a phase separation first? Why?

Data

Gasoline type	Room temperature	Heated temperature	Volume gasoline	Volume water

Reflection

1. Describe how the room temperature gasoline blends compared when adding distilled water to observe a phase change. Did one blend absorb more water than the other blends?
2. How did the temperature impact the volume of water needed to create a phase change in the fuel products?
3. Which fuel product will undergo a phase change with the least volume of water according to the data you collected? How might this phase separation cause harm to a vehicle?