

Passage IV

When an oil is exposed to air, small amounts of reactive *peroxides* can form in the oil. If the peroxide concentration reaches a certain level, the oil will rapidly decompose to form acidic organic compounds such as formic acid. Scientists use an *accelerated oxidation apparatus*, AOA, to model this process on a short time scale (see diagram).

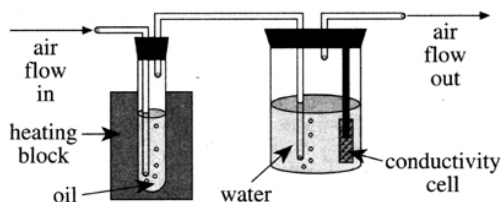


diagram of AOA

A 3 g oil sample is heated to a certain temperature. Starting at time = 0 min, dry air is bubbled through the sample at a constant rate. The flow of air carries organic acids produced in the sample into the flask containing water. The *conductivity* (ease of electric flow) of the water is monitored. The conductivity of the water stays relatively constant until the oil rapidly decomposes. As the oil rapidly decomposes, the conductivity sharply increases. The length of time from 0 min until this increase occurs is the *induction period*.

Biodiesels are renewable fuel oils typically made from soybeans. Scientists did 3 experiments to study 4 biodiesels (BD1–BD4). BD2 was a 50/50 mixture of BD1 and BD4 by volume.

Experiment 1

The induction period was determined for fresh samples of BD1–BD4 at 4 temperatures (see Figure 1).

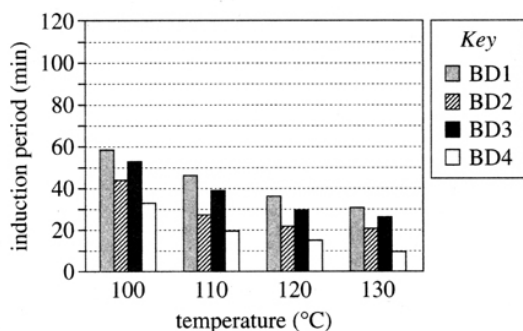


Figure 1

Experiment 2

The induction period was determined for fresh samples of BD1–BD4 at 110°C. Each sample contained 1 of 4 *antioxidants* at a concentration of 500 mg/kg (see Figure 2). Antioxidants are compounds that can inhibit the decomposition of oils exposed to air.

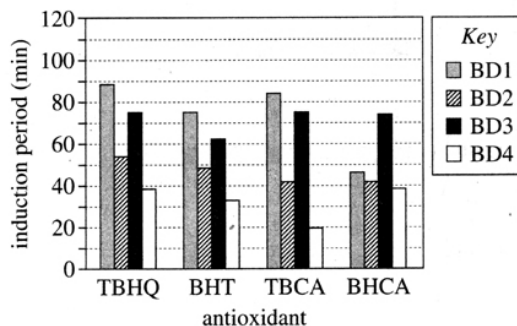


Figure 2

Experiment 3

The induction period was determined for fresh samples of BD1–BD4 at 110°C. Each sample contained a different concentration of the antioxidant TBHQ (see Figure 3).

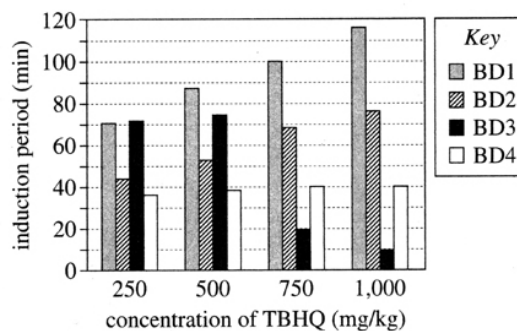


Figure 3

18. In Experiment 3, which of the biodiesels having a TBHQ concentration of 750 mg/kg decomposed most quickly in the AOA ?
- F. BD1
 - G. BD2
 - H. BD3
 - J. BD4
19. A chemist claims that if the antioxidant concentration in a biodiesel is increased from 500 mg/kg to 1,000 mg/kg, the biodiesel's stability will increase. The claim is *inconsistent* with the results in Experiment 3 for which biodiesel?
- A. BD1
 - B. BD2
 - C. BD3
 - D. BD4
20. Suppose a set of trials had been done in Experiment 1 at 115°C. Which of the following would have been the most likely induction periods of BD2 and BD3 ?
- | | BD2 | BD3 |
|----|--------|--------|
| F. | 25 min | 35 min |
| G. | 30 min | 35 min |
| H. | 35 min | 25 min |
| J. | 35 min | 30 min |
21. A sample of fresh BD1 is tested in the AOA as in Experiment 1 and is found to have an induction period of 65 min. At which of the following temperatures was the test most likely conducted?
- A. 95°C
 - B. 105°C
 - C. 115°C
 - D. 125°C
22. In Experiments 1–3, the component of the air bubbling through the biodiesel sample that was primarily responsible for the breakdown of the sample was:
- F. H₂O.
 - G. H₂.
 - H. N₂.
 - J. O₂.
23. Suppose BD5 is made by mixing 250 mL of BD1 with 750 mL of BD4. If a sample of BD5 containing 500 mg/kg of TBHQ were tested as in Experiment 2, its induction period would most likely be:
- A. less than 20 min.
 - B. between 20 min and 40 min.
 - C. between 40 min and 80 min.
 - D. greater than 80 min.