Asian Journal of Chemistry Vol. 22, No. 2 (2010), 1645-1646

NOTE

Usage of Solid Paraffin for Purification, Storage and Handling of Metallic Sodium

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In this study, impure sodium was melted in molten solid paraffin. During this process heavier impurities in metallic sodium, such as sodium oxide and sodium hydroxide were collected under the molten sodium phase, while lighter impurities were collected over the sodium phase. After paraffin was cooled, solid sodium covered with paraffin was obtained.

Key Words: metallic sodium, purification, storage, handling, solid paraffin.

Pure sodium is a soft, silvery-white metal with a faint pink colour when freshly cut[1]. Importance of sodium in technology during the past 40 years or more has been enormous. It is also used largely as a reducing agent in pharmaceutical, perfumery and general chemical industries. In addition to these, because of its good heat transfer and nuclear properties, it is used as a coolant in fast reactors and radioactive activation product (isotope Na^{24}) in system and component designs for safety[1,2]. For example, metallic sodium is most commonly used in liquid metal fast breeder reactor (LMFBR) systems as a heat transfer fluid because of its good technical characteristics, including a low melting point (97.72 ºC), high boiling point (880 ºC), a water-like viscosity when melted (0.4519 cP at 200 ºC), a high thermal conductivity (70.5545 kcal/h.m. ºC at 200 ºC) and a high thermal heat capacity (0.0874 kcal/g. ºC at 200 ºC)[3].

Its affinity to react with air and water is a strong disadvantage. Sodium reacts readily with water to form sodium hydroxide and hydrogen. According to following equations, all three equations are strongly exothermic and occur spontaneously[1]. Eqns. 1-3 show how water and air react with sodium[3].

$$Na + H_2O \rightarrow NaOH + \tfrac{1}{2}H_2 \qquad \Delta G_r^o = -151.72 \text{ kJ} \qquad (1)$$

$$2Na + \tfrac{1}{2}O_2 \rightarrow Na_2O \qquad \Delta G_r^o = -377 \text{ kJ} \qquad (2)$$

$$2Na + O_2 \rightarrow Na_2O_2 \qquad \Delta G_r^o = -439 \text{ kJ} \qquad (3)$$

Metallic sodium is kept in a tightly closed container, stored in a cool, dry, ventilated area to protect against physical damage. Generally, it is stored under nitrogen or kerosene to isolate from air oxygen, air humidity and gases found in air

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such as nitrogen oxides, sulfur oxides and carbon dioxide having acidic character. It is not difficult to handle solid metallic sodium as long as it is covered with a thin layer of paraffin/kerosene/oil to prevent significant oxidation[1]. In addition, it is stored in liquid petroleum products like kerosene.

Despite all the care taken, surface of the metallic sodium is covered with sodium oxide and sodium hydroxide, because of frequent opening and closing of the containers including metallic sodium, especially in laboratories, which cause it to interact with air oxygen and humidity. Thus, contaminated sodium must be cleaned and purified.

In this study, the purification of contaminated metallic sodium and development of a practical method for handling/storage of metallic sodium for a long period were investigated.

Metallic sodium and granular paraffin were purchased from Merck and J.T. Baker, respectively. The experiments were carried out in the glass tubes which has the dimensions of 2 cm × 16 cm. Granular paraffin particles were put into the glass tube and heated over the melting point of metallic sodium (97.72 ºC) by a Bunsen burner. After paraffin melted completely, metallic sodium was cut into small pieces with a knife and each small piece was added in the molten paraffin one by one while the glass tube was continuously heated until all added metallic sodium melted and then it was left at room temperature for cooling. It is very important for metallic sodium not to have bubbles during melting process. After the metallic sodium became a solid form as covered with paraffin, the tube was slightly heated to remove the content of it. Excessive amount of paraffin was cut and taken away. In order to show that sodium covered with paraffin is not reactive with air and water, it was left in a medium that it could be contact with air and water.

Sodium does not react with hydrocarbons. Therefore, it does not react with paraffin having chain length between $C_{20}H_{42}$-$C_{40}H_{82}$. But the melting point of paraffin used must be over the normal handling and transportation temperature. Thus, in this study, paraffin having 60-62 ºC melting points was used. The density of molten sodium is 0.927g/cm^3 and at the melting point of metallic sodium (97.72 ºC) the density of paraffin was 0.8 g/cm^3. Therefore, while sodium was melted in paraffin, sodium hydroxide and sodium oxide (2.10 and 2.27 g/cm^3) are collected at the bottom of the tube and other contaminations having lower densities are collected at the top of the tube. After cooling and removing of sample, excessive amount of paraffin including contaminations was cut and taken away. Sodium covered with paraffin can be stored in any container. When it is necessary, desired amount of sodium can be cut and used.

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(*Received*: 13 May 2009; *Accepted*: 5 November 2009) AJC-8032