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BODMEL: A Compact Apparatus for Simple Distillation Boiling Point and Melting Point Determination

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Abstract The design and working of a new compact glass apparatus, BODMEL, is presented in this paper. This apparatus can be used for the determination of boiling point and for simple distillation of small volumes of liquid organic compounds. The apparatus also provides a safe method for determination of melting points.

Keywords Apparatus, Boiling Point, Melting Point

1. Introduction

The determination of physical constants such as boiling point and melting point is among the key basic organic chemistry laboratory techniques taught in the first year of college chemistry. Both these techniques play a central role in the systematic identification of unknown organic compounds. When large volumes of liquids are available, distillation is the method of choice for boiling point determination. For melting point determination, concentrated sulphuric acid bath taken in a Kjeldahl's flask or Thiele's tube are the preferred methods. Standard apparatus is available and adequate descriptions of use and handling appear in several laboratory text books [1-3].

Small scale and micro scale methods of organic analysis and synthesis have grown over the last couple of decades and are now practised in many parts of the world as these lead to direct environmental and cost benefits. However, the change of scale from macro (multigram scale) to microscale/small scale (usually one tenth the gram and lesser) necessitates the use of appropriately sized apparatus. Since each teaching institute has its own curriculum, the laboratory curricular needs are different as well. This has lead to a lot of stimulation in creativity among specialists in the area. Consequently, a number of papers describing the fabrication and use of new microscale glassware for distillation and boiling point have appeared in literature [4-6]. Specially designed small scale kits and miniaturized versions of standard apparatuses have also come into usage [7]. The prohibitive costs of these apparatuses makes them unsuitable for adoption in teaching laboratories catering to large numbers of students. In order to get the benefits of reduction in scale at affordable cost for our teaching labs, we have designed, fabricated and tested a new piece of glass apparatus which is safe to use, easy to set up, gives quick results and can be used for more than one function.

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2. Construction

It consists of a central tube with a constriction and two finger-like projections close to the neck. Immediately where the constriction finishes, an outer glass jacket begins, covering the lower half of the main tube. It is provided with two holes for contact with atmosphere. This jacket serves as an effective air bath. It is a single-piece apparatus without ground glass joints (Figure 1).

3. Working of Bodmel Apparatus

• Boiling Point Determination

The new apparatus can be used for finding out the boiling point of unknown liquid compounds conveniently by following the procedure as outlined below:

- Securely clamp the apparatus in such a way that the finger-like projections rest slightly above the clamp as shown in Figure 2.
- With the help of a long glass dropper, release the given liquid right at the bottom of the inner tube taking care that no liquid gets into the finger-like projections. The apparatus is designed to work with small volumes. Best results are obtained for volumes in the range 1.0-2.0 mL.
- Drop a tiny piece of boiling chips/porcelain for smooth boiling.
- Introduce a cork carrying a thermometer in such a way that the bulb of thermometer rests in the constriction part of the apparatus. The cork should be secure but not too tight (Figure 2).

- Heat the outer jacket of BODMEL uniformly using a small flame.
- At the boiling point notice the temperature becomes constant and the liquid distils and collects in the finger-like projections.
- The pure liquid can be collected using a fine tipped dropper.

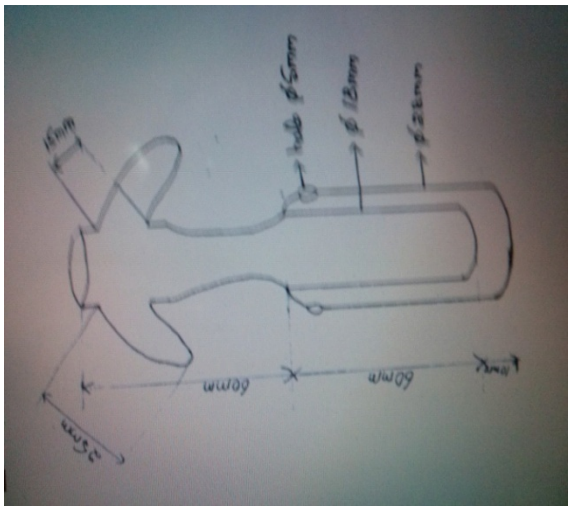

Figure 1. BODMEL Apparatus Design Drawing

B. Melting Point Determination

With the help of a long dropper, approximately 2 mL concentrated H_2SO_4 (safety precautions should be followed while handling concentrated H_2SO_4) is placed in the main tube. The thermometer and capillary filled with compound are stuck together with a drop of viscous H_2SO_4. This assembly is carefully lowered into the acid bath as in conventional methods. The cork is secured and heating done in a uniform manner. Melting points are obtained smoothly.

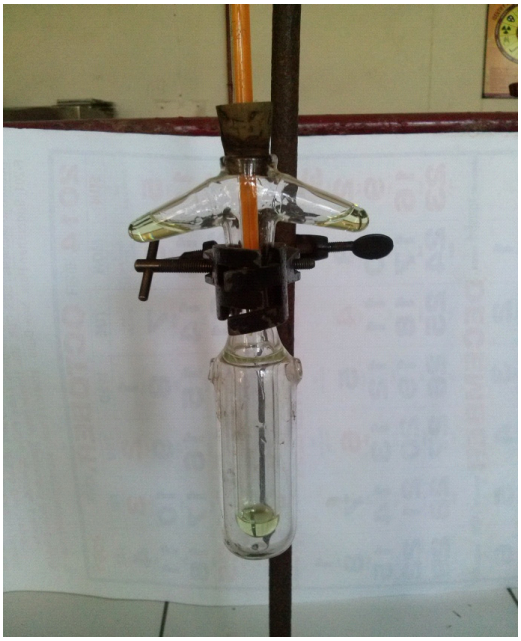

Figure 2. BODMEL Apparatus Working

4. Experimental Results

The results of laboratory testing of BODMEL are presented in table 1.

Table 1. Experimental Determination of Boiling Points and Melting points Using BODMEL Apparatus

Entry	Compound	Boiling Point, ℃ (1)		Melting point ℃ (1)	
		Observed	Literature	Observed	Literatur
1	Acetic acid	117	118		
2	Adipic acid			152	152
3	Anthracene			215-216	216
4	Benzoic acid			121	121
5	Bromobenzene	155	156		
6	Chlorobenzene	132	132		
7	Cinnamaldehyde	252	252		
8	Ethanol	78	78		
9	Ethyl methyl ketone	80	80		
10	Methanol	65	65		
11	Nitrobenzene	210	210		
12	p-Toluidine			44-45	45
13	Salicylaldehyde	197	197		
14	Toluene	111	110		

5. Conclusions

From the description of design of BODMEL and the experimental results presented in Table 1, it is apparent that the apparatus has several advantages.

- Since the volumes used for boiling point determination are small (1.0-2.0 mL), results are achieved quickly. Boiling points are obtained smoothly and within literature values for compounds having low, mid and high boiling ranges.
- The volume of concentrated sulphuric acid used for melting point experiments is also small (~2 mL). The presence of outer jacket makes it especially safe to use. The danger of hot concentrated sulphuric acid spilling is drastically reduced.
- The apparatus is single-piece and compact. Handling is easy. Cleaning of finger-like projections presents no problems; they are reached by an ordinary small bristle brush.
- Absence of ground glass joints provides for cost benefit in fabrication.
- Triple use: **bo**iling point, **d**istillation and **mel**ting point. Triple use is the genesis of the acronym BODMEL.

6. Safety Precautions

Lab coat and safety glasses should be worn throughout the experiments using BODMEL apparatus. The apparatus should be allowed to cool to ambient lab temperature before removing the cork to minimize exposure to vapours. The liquid that collect in finger like projections should be stored in stoppered for further use.

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