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Specifications for Benzene, xylenes and toluenes

Spécifications pour le benzène, les xylènes et les toluènes

Spezifikationen für Benzol, Xylole und Toluole

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BS 135, 458, 805 : 1977

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Foreword

These British Standards have been prepared under the authority of the Tar Products (other than Ammonia) Standards Committee. BS 135, BS 458 and BS 805 were first issued in 1921, 1932 and 1939 respectively, and were previously revised in 1963. The present revisions have been prepared as a result of a review in the light of present-day requirements.

The revised standards have been assembled in a single volume with common appendices, as it is thought that this is a more convenient arrangement for a majority of users of the standards.

The number of grades of benzene specified in BS 135 and of xylene specified in BS 458 has been reduced. Trade in benzene complying with the requirements of BS 135/1, 135/2 and 135/3 : 1963 is declining and is expected soon to disappear. Only a single grade of benzene is therefore specified. The distillation requirements for benzene, previously used to identify the material (by its boiling point) and to indicate purity (by its boiling range), have been deleted because these aspects are defined adequately by the density and crystallizing point respectively.

Three grades of xylene are specified in BS 458. All three are mixtures of xylene isomers and ethylbenzene. The total sulphur content of grade 1 is limited to 10 mg/kg and there is a strict acid-wash test. Grade 2 is the 'ordinary' grade with an acid-wash test clause but no total sulphur limit. Grade 3 contains neither total sulphur nor acid-wash test requirements and may, therefore, contain some unsaturated materials.

Three grades of toluene are now specified in BS 805. Grade 1 (synthesis grade) is a high quality grade normally required only for use as a chemical feedstock. Grade 2 (ordinary grade) is related to a commercially pure toluene (hitherto called nitration grade toluene) and is suitable for most normal commercial usages. Grade 3 (solvent toluene) is a wide-cut fraction, containing predominantly toluene, and is suitable for use in less critical applications.

The distillation requirements for grade 1 toluene have been replaced by limits for benzene and for non-aromatic and C₈ hydrocarbons, determined by a gas-liquid chromatographic method developed by the Institute of Petroleum; grateful acknowledgement is made for permission to reproduce this method. Benzene limits, determined by the same method, have also been included for the other grades of toluene.

The method for the determination of total sulphur content has been changed and, for levels between 2 mg/kg and 10 mg/kg, is now based on a reduction method using Raney

nickel or the Wickbold oxyhydrogen method while, for higher levels up to 2000 mg/kg, either the Wickbold oxyhydrogen method or the lamp method is suitable. Density at 20 °C is now specified in place of specific gravity at 15.5/15.5 °C.

NOTE. A slightly different version of the Wickbold method, developed as a general European Standard for petroleum products, is given in BS 5379 [EN 41].

The distillation test now specified is that developed by the Institute of Petroleum, which is published as BS 4700.

The limits for colour are now quoted in terms of Hazen units and the method for measurement given in appendix A is technically identical with ISO 2211.

By agreement with the Standardization of Tar Products Test Committee (S.T.P.T.C.), some of the methods of testing and descriptions of apparatus contained in the appendices have been reproduced, with editorial modifications, from the publication 'Standard methods of testing tar and its products' (6th edition, 1967)*.

NOTE. The following definitions have been approved by the S.T.P.T.C. and have been adopted for the purposes of these British Standards.

accuracy, for statistical purposes, is the closeness of the test results to the true value. Variations due to sampling errors are included and these are often responsible for most of the difference between the test result and the true value. In these standards no estimates of the accuracy of the test methods are given.

precision is the closeness of agreement among test results obtained under any definite test conditions. Thus, a method may be precise without being accurate. Repeatability and reproducibility are aspects of precision under two such defined sets of conditions. See also BS 4306.

repeatability is a measure of the precision of test results obtained by one operator using one set of apparatus. In these standards, repeatability (*r*) is the difference between duplicate results on the same sample that would be equalled or exceeded, in the long run, in only one case in twenty.

reproducibility is a measure of the precision of test results obtained by different operators using different sets of the same apparatus. In these standards, reproducibility (*R*) is defined as the difference between a single result by one operator at one laboratory and a single result by another operator at another laboratory that would be equalled or exceeded, in the long run, in only one case in twenty.

WARNING. Benzene is highly flammable and harmful by inhalation, ingestion and skin absorption.

Certification. Attention is drawn to the certification facilities described on the inside back cover of this publication.

* These methods are intended to be carried out in accordance with the general principles and apparatus requirements laid down in the S.T.P.T.C. publication mentioned.

British Standard Specification for Benzene

1. Scope

This British Standard specifies requirements for benzene suitable for industrial purposes.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Description

The material shall be clear and free from separated impurities, as determined by visual inspection. It consists essentially of benzene, C_6H_6 .

4. Colour

The material shall not be darker in colour than the 20 Hazen unit standard solution, when tested by the method described in appendix A.

5. Density

The density of the material at $20^\circ C$ shall be not lower than 0.878 g/ml and not greater than 0.881 g/ml, when tested by one of the methods described in appendix B.

6. Water

The material at $20^\circ C$ shall be free from undissolved water, when viewed by transmitted light.

7. Acid-wash test

The acid layer shall not be darker in colour than a solution of 0.2 g of potassium dichromate in 1000 ml of a mixture of equal volumes of concentrated sulphuric acid, 98 % (m/m) (36N), and water, complying with the requirements of BS 3978, when the material is tested by the method described in appendix C.

8. Total sulphur content

The material shall not contain more than 2 mg/kg of total sulphur, when determined by either of the methods described in appendices D and L.

9. Free sulphur content

The material shall not contain more than 0.5 mg/kg of free sulphur, when determined by the method described in appendix E.

10. Hydrogen sulphide

The material shall be free from hydrogen sulphide, when tested by the method described in appendix F.

11. Mercaptans

The material shall not give a positive reaction for mercaptans, when tested by the method described in appendix G.

12. Neutrality

The material shall give neither an acid nor an alkaline reaction, when tested by the method described in appendix H.

13. Residue on evaporation

The residue on evaporation shall not exceed 5 mg/100 ml, when the material is tested by the method described in appendix J.

14. Crystallizing point

The crystallizing point (dry) of the material shall be not lower than $5.35^\circ C$, when determined by the method described in appendix K.

15. Sampling

A representative sample of the material, taken from the bulk and measuring not less than 1000 ml, is necessary for the purpose of examination. In the absence of any instructions to the contrary, take sufficient material to provide three separate samples and, after thorough mixing, immediately transfer it to clean, dry, air-tight, narrow-necked, glass-stoppered bottles of such a size that they are nearly filled by the sample. Do not use rubber stoppers or composition corks for closing the bottles containing these samples. Sealing wax or other plastics material, if used, should be applied in such a way that it cannot contaminate the sample when the bottles are opened. Cover the stoppers of the sample bottles with oil-proof paper, metal foil, viscose or other suitable impervious material to keep moisture and dust from the mouths of the bottles and for protection while being handled.

Recommended methods for sampling are given in BS 616.

British Standard Specification for Xylenes

1. Scope

This British Standard specifies requirements for xylene (grade 1), xylene (grade 2) and solvent xylene (grade 3), suitable for industrial purposes.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Xylene (grade 1) (designated BS 458/1)

3.1 Description. The material shall be clear and free from separated impurities, as determined by visual inspection. It consists essentially of xylene isomers, $C_6H_4(CH_3)_2$, and ethylbenzene, $C_6H_5 \cdot C_2H_5$.

3.2 Colour. The material shall not be darker in colour than the 20 Hazen unit standard solution, when tested by the method described in appendix A.

3.3 Density. The density of the material at $20^\circ C$ shall be not lower than 0.855 g/ml and not greater than 0.870 g/ml, when tested by one of the methods described in appendix B.

3.4 Water. The material at $20^\circ C$ shall be free from undissolved water, when viewed by transmitted light.

3.5 Distillation. The temperature range between the initial boiling point and the dry point shall not be greater than $5^\circ C$, when the material is tested by the method described in BS 4700*. The thermometer used shall be that with the range $98^\circ C$ to $152^\circ C$, specified in clause 4(e) of BS 4700 : 1971.

The distillation range thus determined shall include the temperature $139.3^\circ C$.

3.6 Acid-wash test. The acid layer shall not be darker in colour than a solution of 0.5 g of potassium dichromate in 1000 ml of a mixture of equal volumes of concentrated sulphuric acid, 98 % (m/m) (36N), and water, complying with the requirements of BS 3978, when the material is tested by the method described in appendix C.

3.7 Total sulphur content. The material shall not contain more than 10 mg/kg of total sulphur, when determined by either of the methods described in appendices D and L.

3.8 Hydrogen sulphide content. The material shall be free from hydrogen sulphide, when tested by the method described in appendix F.

3.9 Mercaptans. The material shall not give a positive reaction for mercaptans, when tested by the method described in appendix G.

3.10 Neutrality. The material shall give neither an acid nor an alkaline reaction, when tested by the method described in appendix H.

3.11 Residue on evaporation. The residue on evaporation shall not exceed 5 mg/100 ml, when the material is tested by the method described in appendix J.

3.12 Flashpoint. The flashpoint of the material shall be not lower than $73^\circ F$ ($22.8^\circ C$), when determined by the method described in BS 3442 : Part 1†.

3.13 Sampling. A representative sample of the material, taken from the bulk and measuring not less than 1000 ml, is necessary for the purpose of examination. In the absence of any instructions to the contrary, take sufficient material to provide three separate samples and, after thorough mixing, immediately transfer it to clean, dry, air-tight, amber-coloured, narrow-necked, glass-stoppered bottles of such a size that they are nearly filled by the sample. Do not use rubber stoppers or composition corks for closing the bottles containing these samples. Sealing wax or other plastics material, if used, should be applied in such a way that it cannot contaminate the sample when the bottles are opened. Cover the stoppers of the sample bottles with oil-proof paper, metal foil, viscose or other suitable impervious material to keep moisture and dust from the mouths of the bottles and for protection while being handled.

Recommended methods for sampling are given in BS 616.

4. Xylene (grade 2) (designated BS 458/2)

4.1 Description. The material shall be clear and free from separated impurities, as determined by visual inspection. It consists essentially of xylene isomers, $C_6H_4(CH_3)_2$, and ethylbenzene, $C_6H_5 \cdot C_2H_5$.

4.2 Colour. The material shall not be darker in colour than the 20 Hazen unit standard solution, when tested by the method described in appendix A.

4.3 Density. The density of the material at $20^\circ C$ shall be not lower than 0.855 g/ml and not greater than 0.870 g/ml, when tested by one of the methods described in appendix B.

4.4 Water. The material at $20^\circ C$ shall be free from undissolved water, when viewed by transmitted light.

*Some of the apparatus required is specified in BS 4349.

†See footnote to 5.11.

4.5 Distillation. The temperature range between the initial boiling point and the dry point shall not be greater than 10 °C, when the material is tested by the method described in BS 4700*. The thermometer used shall be that with the range 98 °C to 152 °C, specified in clause 4(e) of BS 4700 : 1971.

The distillation range thus determined shall include the temperature 139.3 °C.

4.6 Acid-wash test. The acid layer shall not be darker in colour than a solution of 2.0 g of potassium dichromate in 1000 ml of a mixture of equal volumes of concentrated sulphuric acid, 98 % (m/m) (36N), and water, complying with the requirements of BS 3978, when the material is tested by the method described in appendix C.

4.7 Free sulphur content. The material shall not contain more than 12 mg/kg of free sulphur, when determined by the method described in appendix E.

4.8 Hydrogen sulphide. The material shall be free from hydrogen sulphide, when tested by the method described in appendix F.

4.9 Mercaptans. The material shall not give a positive reaction for mercaptans, when tested by the method described in appendix G.

4.10 Neutrality. The material shall give neither an acid nor an alkaline reaction, when tested by the method described in appendix H.

4.11 Residue on evaporation. The residue on evaporation shall not exceed 10 mg/100 ml, when the material is tested by the method described in appendix J.

4.12 Flashpoint. The flashpoint of the material shall be not lower than 73 °F (22.8 °C), when determined by the method described in BS 3442 : Part 1†.

4.13 Sampling. A representative sample of the material, taken from the bulk and measuring not less than 1000 ml, is necessary for the purpose of examination. In the absence of any instructions to the contrary, take sufficient material to provide three separate samples and, after thorough mixing, immediately transfer it to clean, dry, air-tight, amber-coloured, narrow-necked, glass-stoppered bottles of such a size that they are nearly filled by the sample. Do not use rubber stoppers or composition corks for closing the bottles containing these samples. Sealing wax or other plastics material, if used, should be applied in such a way that it cannot contaminate the sample when the bottles are opened. Cover the stoppers of the sample bottles with oil-proof paper, metal foil, viscose or other suitable impervious material to keep moisture and dust from the mouths of the bottles and for protection while being handled.

Recommended methods for sampling are given in BS 616.

5. Xylene (grade 3) (designated BS 458/3)

5.1 Description. The material shall be clear and free from separated impurities, as determined by visual inspection. It consists essentially of xylene isomers, $C_6H_4(CH_3)_2$,

and ethylbenzene, $C_6H_5 \cdot C_2H_5$, but may include small quantities of unsaturated compounds.

5.2 Colour. The material shall not be darker in colour than the 20 Hazen unit standard solution, when tested by the method described in appendix A.

5.3 Density. The density of the material at 20 °C shall be not lower than 0.855 g/ml and not greater than 0.870 g/ml, when tested by one of the methods described in appendix B.

5.4 Water. The material at 20 °C shall be free from undissolved water, when viewed by transmitted light.

5.5 Distillation. The temperature range between the initial boiling point and the dry point shall not be greater than 10 °C, when the material is tested by the method described in BS 4700*. The thermometer used shall be that with the range 98 °C to 152 °C, specified in clause 4(e) of BS 4700 : 1971.

The distillation range thus determined shall include the temperature 139.3 °C.

5.6 Free sulphur content. The material shall not contain more than 12 mg/kg of free sulphur, when determined by the method described in appendix E.

5.7 Hydrogen sulphide. The material shall be free from hydrogen sulphide, when tested by the method described in appendix F.

5.8 Mercaptans. The material shall not give a positive reaction for mercaptans, when tested by the method described in appendix G.

5.9 Neutrality. The material shall give neither an acid nor an alkaline reaction, when tested by the method described in appendix H.

5.10 Residue on evaporation. The residue on evaporation shall not exceed 10 mg/100 ml, when the material is tested by the method described in appendix M.

5.11 Flashpoint. The flashpoint of the material shall be not lower than 73 °F (22.8 °C), when determined by the method described in BS 3442 : Part 1†.

5.12 Sampling. A representative sample of the material, taken from the bulk and measuring not less than 1000 ml, is necessary for the purpose of examination. In the absence of any instructions to the contrary, take sufficient material to provide three separate samples and, after thorough mixing, immediately transfer it to clean, dry, air-tight, amber-coloured, narrow-necked, glass-stoppered bottles of such a size that they are nearly filled by the sample. Do not use rubber stoppers or composition corks for closing the bottles containing these samples. Sealing wax or other plastics material, if used, should be applied in such a way that it cannot contaminate the sample when the bottles are opened. Cover the stoppers of the sample bottles with oil-proof paper, metal foil, viscose or other suitable impervious material to keep moisture and dust from the mouths of the bottles and for protection while being handled.

Recommended methods for sampling are given in BS 616.

*Some of the apparatus required is specified in BS 4349.

†This flashpoint limit, together with the specified test method, constitutes an essential requirement for all material for which compliance with BS 458 is claimed. This requirement ensures that the material is excluded from the provisions of the Petroleum (Consolidation) Act, 1928, and its subsequent amendments. However, if the supplier and customer so wish, they may agree to an additional flashpoint limit using the method specified in BS 3900 : Part A8 (which is equivalent to International Standard ISO 1516 : 1973).

British Standard Specification for Toluenes

1. Scope

This British Standard specifies requirements for toluene (grade 1), toluene (grade 2) and toluene (grade 3), suitable for industrial purposes.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Toluene (grade 1) (designated BS 805/1)

3.1 Description. The material shall be clear and free from separated impurities, as determined by visual inspection. It consists essentially of toluene, $C_6H_5CH_3$.

3.2 Colour. The material shall not be darker in colour than the 20 Hazen unit standard solution, when tested by the method described in appendix A.

3.3 Density. The density of the material at 20 °C shall be not lower than 0.864 g/ml and not greater than 0.868 g/ml, when tested by one of the methods described in appendix B.

3.4 Water. The material at 20 °C shall be free from undissolved water, when viewed by transmitted light.

3.5 Acid-wash test. The acid layer shall not be darker in colour than a solution of 0.2 g of potassium dichromate in 1000 ml of a mixture of equal volumes of concentrated sulphuric acid, 98 % (m/m) (36N), and water, complying with the requirements of BS 3978, when the material is tested by the method described in appendix C.

3.6 Total sulphur content. The material shall not contain more than 2 mg/kg of total sulphur, when determined by either of the methods described in appendices D and L.

3.7 Mercaptans. The material shall not give a positive reaction for mercaptans, when tested by the method described in appendix G.

3.8 Neutrality. The material shall give neither an acid nor an alkaline reaction, when tested by the method described in appendix H.

3.9 Residue on evaporation. The residue on evaporation shall not exceed 5 mg/100 ml, when the material is tested by the method described in appendix J.

3.10 Benzene content. The material shall not contain more than 0.05 % by mass of benzene, when determined by the gas-liquid chromatographic method described in appendix P.

3.11 Non-aromatic hydrocarbons content. The material shall not contain more than 0.2 % by mass of non-aromatic hydrocarbons, when determined by the gas-liquid chromatographic method described in appendix P.

3.12 C_8 aromatic hydrocarbons content. The material shall not contain more than 0.05 % by mass of C_8 aromatic hydrocarbons, when determined by the gas-liquid chromatographic method described in appendix P.

3.13 Sampling. A representative sample of the material, taken from the bulk and measuring not less than 1000 ml, is necessary for the purpose of examination. In the absence of any instructions to the contrary, take sufficient material to provide three separate samples and, after thorough mixing, immediately transfer it to clean, dry, air-tight, narrow-necked, glass-stoppered bottles of such a size that they are nearly filled by the sample. Do not use rubber stoppers or composition corks for closing the bottles containing these samples. Sealing wax or other plastics material, if used, should be applied in such a way that it cannot contaminate the sample when the bottles are opened. Cover the stoppers of sample bottles with oil-proof paper, metal foil, viscose or other suitable impervious material to keep moisture and dust from the mouths of the bottles and for protection while being handled.

Recommended methods for sampling are given in BS 616.

4. Toluene (grade 2) (designated BS 805/2)

4.1 Description. The material shall be clear and free from separated impurities, as determined by visual inspection. It consists essentially of toluene, $C_6H_5CH_3$.

4.2 Colour. The material shall not be darker in colour than the 20 Hazen unit standard solution, when tested by the method described in appendix A.

4.3 Density. The density of the material at 20 °C shall be not lower than 0.864 g/ml and not greater than 0.868 g/ml, when tested by one of the methods described in appendix B.

4.4 Water. The material at 20 °C shall be free from undissolved water, when viewed by transmitted light.

4.5 Distillation. The temperature range between the initial boiling point and the dry point shall not be greater than 1.0 °C, when the material is tested by the method described in BS 4700*. The thermometer used shall be that with the range 72 °C to 126 °C, specified in clause 4(e) of BS 4700 : 1971.

The distillation range thus determined shall include the temperature 110.6 °C.

* Some of the apparatus required is specified in BS 4349.

4.6 Acid-wash test. The acid layer shall not be darker in colour than a solution of 0.2 g of potassium dichromate in 1000 ml of a mixture of equal volumes of concentrated sulphuric acid, 98 % (*m/m*) (36N), and water, complying with the requirements of BS 3978, when the material is tested by the method described in appendix C.

4.7 Total sulphur content. The material shall not contain more than 1000 mg/kg of total sulphur, when determined by either of the methods described in appendices L and N.

4.8 Free sulphur content. The material shall not contain more than 4 mg/kg of free sulphur, when determined by the method described in appendix E.

4.9 Hydrogen sulphide. The material shall be free from hydrogen sulphide, when tested by the method described in appendix F.

4.10 Mercaptans. The material shall not give a positive reaction for mercaptans, when tested by the method described in appendix G.

4.11 Neutrality. The material shall give neither an acid nor an alkaline reaction, when tested by the method described in appendix H.

4.12 Residue on evaporation. The residue on evaporation shall not exceed 5 mg/100 ml, when the material is tested by the method described in appendix J.

4.13 Benzene content. The material shall not contain more than 0.5 % by mass of benzene, when determined by the gas-liquid chromatographic method described in appendix P.

4.14 Sampling. A representative sample of the material, taken from the bulk and measuring not less than 1000 ml, is necessary for the purpose of examination. In the absence of any instructions to the contrary, take sufficient material to provide three separate samples and, after thorough mixing, immediately transfer it to clean, dry, air-tight, narrow-necked, glass-stoppered bottles of such a size that they are nearly filled by the sample. Do not use rubber stoppers or composition corks for closing the bottles containing these samples. Sealing wax or other plastics material, if used, should be applied in such a way that it cannot contaminate the sample when the bottles are opened. Cover the stoppers of the sample bottles with oil-proof paper, metal foil, viscose or other suitable impervious material to keep moisture and dust from the mouths of the bottles and for protection while being handled.

Recommended methods for sampling are given in BS 616.

5. Toluene (grade 3) (designated BS 805/3)

5.1 Description. The material shall be clear and free from separated impurities, as determined by visual inspection. It consists essentially of toluene, $C_6H_5CH_3$.

5.2 Colour. The material shall not be darker in colour than the 20 Hazen unit standard solution, when tested by the method described in appendix A.

5.3 Density. The density of the material at 20 °C shall be not lower than 0.835 g/ml and not greater than 0.870 g/ml, when tested by one of the methods described in appendix B.

5.4 Water. The material at 20 °C shall be free from undissolved water, when viewed by transmitted light.

5.5 Distillation. The initial boiling point shall be not lower than 100 °C and the volume collected at 120 °C (per cent recovery) shall be not lower than 90 % (*v/v*), when the material is tested by the method described in BS 4700*. The thermometer used shall be that with the range 72 °C to 126 °C, specified in clause 4(e) of BS 4700 : 1971.

5.6 Acid-wash test. The acid layer shall not be darker in colour than a solution of 1.5 g of potassium dichromate in 1000 ml of a mixture of equal volumes of concentrated sulphuric acid, 98 % (*m/m*) (36N), and water, complying with the requirements of BS 3978, when the material is tested by the method described in appendix C.

5.7 Total sulphur content. The material shall not contain more than 2000 mg/kg of total sulphur, when determined by either of the methods described in appendices L and N.

5.8 Free sulphur content. The material shall not contain more than 12 mg/kg of free sulphur, when determined by the method described in appendix E.

5.9 Hydrogen sulphide. The material shall be free from hydrogen sulphide, when tested by the method described in appendix F.

5.10 Mercaptans. The material shall not give a positive reaction for mercaptans, when tested by the method described in appendix G.

5.11 Neutrality. The material shall give neither an acid nor an alkaline reaction, when tested by the method described in appendix H.

5.12 Residue on evaporation. The residue on evaporation shall not exceed 5 mg/100 ml, when the material is tested by the method described in appendix J.

5.13 Benzene content. The material shall not contain more than 1.0 % by mass of benzene, when determined by the gas-liquid chromatographic method described in appendix P.

5.14 Sampling. A representative sample of the material, taken from the bulk and measuring not less than 1000 ml, is necessary for the purpose of examination. In the absence of any instructions to the contrary, take sufficient material to provide three separate samples and, after thorough mixing, immediately transfer it to clean, dry, air-tight, amber-coloured, narrow-necked, glass-stoppered bottles of such a size that they are nearly filled by the sample. Do not use rubber stoppers or composition corks for closing the bottles containing these samples. Sealing wax or other plastics material, if used, should be applied in such a way that it cannot contaminate the sample when the bottles are opened. Cover the stoppers of the sample bottles with oil-proof paper, metal foil, viscose or other suitable impervious material to keep moisture and dust from the mouths of the bottles and for protection while being handled.

Recommended methods for sampling are given in BS 616.

* Some of the apparatus required is specified in BS 4349.

Appendix A

Method for the measurement of colour

(Technically identical with ISO 2211)

A.1 Principle. Comparison of the colour of a sample with that of colour standards, and expression of the result in terms of Hazen (platinum-cobalt) colour units.

A.2 Definition. For the purposes of these British Standards, the following definition applies.

Hazen colour unit. The colour of a solution containing 1 mg of platinum, in the form of chloroplatinic acid, per 1000 ml in the presence of 2 mg of cobalt (II) chloride hexahydrate per 1000 ml.

A.3 Reagents. The reagents used are as follows; they shall be of recognized and analytical reagent quality. Water complying with the requirements of BS 3978 shall be used in the test.

A.3.1 Cobalt (II) chloride hexahydrate ($\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$).

A.3.2 Hydrochloric acid, 1.18 g/ml, approximately 36 % (m/m) solution, or about 11N.

A.3.3 Chloroplatinic acid. Dissolve 0.50 g of platinum in a sufficient quantity of aqua regia in a glass or porcelain dish by heating on a boiling waterbath. When the metal has dissolved, evaporate the solution to dryness. Add 2 ml of the hydrochloric acid (A.3.2) and again evaporate to dryness. Repeat this operation twice more. In this way 1.06 g of chloroplatinic acid are obtained; or

A.3.4 Potassium chloroplatinate (K_2PtCl_6).

A.4 Apparatus. Ordinary laboratory apparatus is required together with two matched flat-based colorimetric tubes with a graduation mark at least 100 mm above the base. Suitable tubes are available commercially as 50 ml or 100 ml Nessler cylinders (see BS 612), but should be obtained in pairs matched with respect to colour of glass and height of graduation mark above the base.

A.5 Preparation of standard colorimetric solutions

A.5.1 Standard colorimetric solution, 500 Hazen units. Dissolve 1.00 g of the cobalt chloride (A.3.1) and the equivalent of 0.50 g of platinum, i.e. either 1.06 g of the chloroplatinic acid (A.3.3) or 1.25 g of the potassium chloroplatinate (A.3.4), in water in a 1000 ml one-mark volumetric flask (see BS 1792), add 100 ml of the hydrochloric acid (A.3.2), mix and dilute to the mark with water.

This solution has a colour of 500 Hazen units.

A.5.2 Standard Hazen matching solutions (diluted solutions). Prepare diluted standard colorimetric solutions

Volume of standard colorimetric solution (A.5.1)	Corresponding colour
ml	Hazen units
0	0
1	5
2	10
3	15
4	20
5	25
6	30
7	35
8	40
10	50

in the specification range, or in the sample colour range, by measuring the required volume of the standard colorimetric solution (A.5.1), as shown in the above table, into 100 ml one-mark volumetric flasks; dilute to the mark with water and mix.

A.5.3 Storage. Store these solutions (A.5.1 and A.5.2) in the dark in stoppered glass bottles. Under these conditions the standard colorimetric solution (A.5.1) is stable for 1 year. The standard Hazen matching solutions (A.5.2), although stable for at least 1 month, shall preferably be prepared fresh.

A.6 Procedure. Pour into one of the colorimetric tubes (A.4) a quantity of the sample sufficient to fill it to the 50 ml graduation mark. Similarly pour the standard Hazen matching solution (A.5.2) that appears to have a similar colour into the other tube, to the mark.

Compare the colour of the sample with that of the standard by looking down the tubes from top to bottom against a white background, strongly illuminated by daylight or by an electric 'daylight' lamp, taking care to avoid any side illumination.

Repeat, if necessary, with other standard Hazen matching solutions until the closest match is obtained.

NOTE. Instruments are available which permit visual comparison of a liquid of a given depth with a moving tinted glass disc corresponding to the different standard Hazen matching solutions. The use of such instruments, whose standards are very stable, is permissible provided that the instrument gives correct values when checked against the standard colorimetric solutions (A.5.1 and A.5.2).

Alternatively, a colorimeter or spectrophotometer may be used, after standardizing the instrument by means of the standard colorimetric solutions (A.5.1 and A.5.2).

A.7 Expression of results. Express the colour of the sample as the number of Hazen colour units corresponding to the standard Hazen matching solution having the closest match to the sample.

If the colour of the sample does not correspond to that of any of the standard Hazen matching solutions (brownish-yellow), give, if possible, an estimate of the colour and a description of the observed colour.

Appendix B

Method for the determination of density at 20 °C

B.1 Definition. For the purposes of these British Standards, the following definition applies.

density. The mass per unit volume at a given temperature, called the reference temperature. For the purposes of the standard tests, density is expressed in g/ml. For all products the reference temperature is 20 °C.

This definition is concerned with mass, not with weight in air, but the conversion tables given in the pycnometer method make allowance for the weighing in air. The scales of density hydrometers comply with the requirements of BS 718 are graduated in terms of mass.

B.2 Pycnometer method

B.2.1 Apparatus. The following apparatus is required.

B.2.1.1 Pycnometer, as shown in figure 1, nominal capacity 10 ml, with support.

B.2.1.2 Waterbath, glass-sided, of depth greater than 300 mm, thermostatically controlled to within 0.1 °C at any convenient temperature between 10 °C and 30 °C.

B.2.1.3 Thermometers, S.T.P.T.C. Schedule Nos. T1d and T5d, as specified in appendix Q, are convenient.

B.2.2 Procedure

B.2.2.1 Cleaning. Before calibrating the pycnometer, or when any liquid fails to drain cleanly from the walls or capillary tube of the pycnometer, clean it as follows. Fill the pycnometer with chromic acid solution or alternatively use one of the special detergents*. Allow to stand overnight, empty and rinse well with water, complying with the requirements of BS 3978, followed by anhydrous acetone. Dry the pycnometer by passing a slow stream of dry filtered air through it. Between determinations rinse the pycnometer with toluene followed by anhydrous acetone and dry it as before.

B.2.2.2 General procedure. Remove any static charge from the dry, clean pycnometer, which may conveniently be done by breathing on it, or alternatively by wiping it with a clean, lint-free cloth slightly dampened with water.

Suspend the pycnometer in the balance case for 15 min, then weigh it to the nearest 0.1 mg.

Fill the pycnometer by holding it in an upright position and placing the hooked tip in the liquid; the liquid will be drawn over the bend in the capillary tube by surface tension and the pycnometer will then fill by syphoning. Break the syphon when the liquid level in the bulb arm of the pycnometer reaches the graduated capillary tube. Clean the hooked tip, remove any static charge and weigh as described above. Calculate the mass of liquid in the pycnometer. Place the filled pycnometer in the holder and place the assembly in the waterbath so that the pycnometer is vertical and the liquid levels in the capillary arms are just below the surface of the water. When the liquid has reached the waterbath temperature as indicated by a static liquid level (usually in about 10 min) read the liquid levels in the capillary arms to the nearest 0.2 of a small division. This shall be done while the instrument is still in the waterbath. Record the sum of the two readings to give the scale volume and also record the temperature of the waterbath to the nearest 0.1 °C.

B.2.2.3 Calibration. Using water complying with the requirements of BS 3978 and freshly boiled and cooled, and following the procedure described in B.2.2.2, record the mass of water, the scale volume and the temperature reading for a filling that gives a water level in the pycnometer that is near the top of each scale. Repeat this operation three times, removing a little water each time, so that the series of scale volumes obtained is spaced at approximately equal distances over the whole length of the pycnometer scale.

For each series of recordings calculate ${}_wV_{20}$, the volume of the pycnometer at 20 °C, as follows:

$${}_wV_{20} = {}_wm_t \times M_1$$

where

- ${}_wm_t$ is the mass of water in the pycnometer at t °C (in g)
- M_1 is the multiplication factor, obtained from table 1 under t
- t is the waterbath temperature (in °C)

*'Decon 90' has been found suitable.

Plot the corresponding scale volumes and volumes at 20 °C and construct a mean straight line through the four points none of which should be more than half a pycnometer scale division from this line. If this limitation is not satisfied and, after making further checks, it is found that an acceptable straight line cannot be constructed through the points, a non-uniform bore of the capillary tubes is indicated and the pycnometer shall be rejected.

The line so obtained is the calibration graph of the pycnometer relating the scale volume to the volume of the pycnometer at 20 °C.

B.2.2.4 Sample density. Using the sample and following the procedure described above, obtain the mass, the scale volume and the temperature reading for one filling. Calculate ρ_{20} , the density of the sample at 20 °C, as follows:

$$\rho_{20} = \frac{{}_sm_t}{{}_wV_{20}} \cdot M_2 + 0.0012$$

where

- ${}_sm_t$ is the mass of sample at t °C (in g)
- ${}_wV_{20}$ is the volume of the pycnometer at 20 °C, obtained from the sample scale volume and the calibration graph (in ml)
- M_2 is the multiplication factor obtained from table 2 under t
- t is the waterbath temperature (in °C)

B.2.3 Precision. The figures given in B.2.3.1 and B.2.3.2 have been determined on benzene, toluene and xylene.

B.2.3.1 Repeatability. Duplicate results by the same operator should be considered suspect if they differ by more than 0.0002 g/ml.

B.2.3.2 Reproducibility. Single results submitted by each of two laboratories should be considered suspect if they differ by more than 0.0003 g/ml.

B.3 Hydrometer method

B.3.1 Apparatus. The following apparatus is required.

B.3.1.1 Density hydrometer, complying with series L50 of BS 718, calibrated for the determination of density at 20 °C, for use in liquids of low surface tension, and constructed of soda-lime glass.

The hydrometer shall be examined before use to see that there has been no displacement of the paper scale. Any displacement can be detected by reference to the means provided for this purpose, for example a horizontal line etched on the stem and the corresponding datum line marked on the paper scale, thus: . If the scale has been displaced the hydrometer shall be recertified.

The readings of a hydrometer depend to some extent on the surface tension of the liquid in which the instrument is used, but British Standard series L50 hydrometers are calibrated at surface tensions appropriate to the products in these standards, and respond little, in relation to the subdivision of their respective scales, to such differences in surface tension as occur in these liquids. Reference may be made to BS 718 for fuller information on hydrometry.

B.3.1.2 Hydrometer vessel. A cylindrical glass vessel, free from local irregularities producing distortion, and several millimetres greater in diameter than the hydrometer bulb diameter; a 1000 ml measuring cylinder, complying with the requirements of BS 604, is suitable.

Table 1. Multiplication factors (M_v) for conversion of mass of water at t °C to volume of vessel at 20 °C (see B.2.3.3)

t °C	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
10	1.001 45	1.001 46	1.001 47	1.001 49	1.001 49	1.001 50	1.001 50	1.001 51	1.001 52	1.001 53
11	1.001 54	1.001 55	1.001 56	1.001 57	1.001 58	1.001 59	1.001 60	1.001 61	1.001 62	1.001 63
12	1.001 64	1.001 65	1.001 66	1.001 67	1.001 68	1.001 69	1.001 70	1.001 71	1.001 72	1.001 74
13	1.001 75	1.001 76	1.001 77	1.001 78	1.001 80	1.001 81	1.001 82	1.001 83	1.001 85	1.001 86
14	1.001 87	1.001 88	1.001 90	1.001 91	1.001 92	1.001 94	1.001 95	1.001 97	1.001 98	1.001 99
15	1.002 01	1.002 02	1.002 04	1.002 05	1.002 06	1.002 08	1.002 09	1.002 11	1.002 12	1.002 14
16	1.002 15	1.002 17	1.002 18	1.002 20	1.002 22	1.002 23	1.002 25	1.002 26	1.002 28	1.002 30
17	1.002 31	1.002 33	1.002 35	1.002 36	1.002 38	1.002 40	1.002 41	1.002 43	1.002 45	1.002 46
18	1.002 48	1.002 50	1.002 52	1.002 54	1.002 55	1.002 57	1.002 59	1.002 61	1.002 63	1.002 65
19	1.002 66	1.002 68	1.002 70	1.002 72	1.002 74	1.002 76	1.002 78	1.002 80	1.002 82	1.002 84
20	1.002 86	1.002 88	1.002 90	1.002 92	1.002 94	1.002 96	1.002 98	1.003 00	1.003 02	1.003 04
21	1.003 06	1.003 08	1.003 10	1.003 12	1.003 14	1.003 16	1.003 18	1.003 21	1.003 23	1.003 25
22	1.003 27	1.003 29	1.003 32	1.003 34	1.003 36	1.003 38	1.003 40	1.003 43	1.003 45	1.003 47
23	1.003 49	1.003 52	1.003 54	1.003 56	1.003 59	1.003 61	1.003 63	1.003 66	1.003 68	1.003 70
24	1.003 73	1.003 75	1.003 78	1.003 80	1.003 82	1.003 85	1.003 87	1.003 90	1.003 92	1.003 95
25	1.003 97	1.004 00	1.004 02	1.004 05	1.004 07	1.004 10	1.004 12	1.004 15	1.004 17	1.004 20
26	1.004 22	1.004 25	1.004 27	1.004 30	1.004 33	1.004 35	1.004 38	1.004 41	1.004 43	1.004 46
27	1.004 49	1.004 51	1.004 54	1.004 57	1.004 59	1.004 62	1.004 63	1.004 67	1.004 70	1.004 73
28	1.004 76	1.004 79	1.004 81	1.004 84	1.004 87	1.004 90	1.004 93	1.004 95	1.004 98	1.005 01
29	1.005 04	1.005 07	1.005 10	1.005 13	1.005 15	1.005 18	1.005 21	1.005 24	1.005 27	1.005 30

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Table 2. Multiplication factors (M_2) for conversion of mass/volume ratio at t °C to uncorrected density at 20 °C (see B.2.2.4)

t °C	Benzene	Toluene	Xylene
10.0	0.988 22	0.989 42	0.990 28
.2	0.988 45	0.989 62	0.990 47
.4	0.988 68	0.989 83	0.990 66
.6	0.988 91	0.990 04	0.990 85
.8	0.989 14	0.990 24	0.991 04
11.0	0.989 37	0.990 45	0.991 23
.2	0.989 60	0.990 66	0.991 42
.4	0.989 82	0.990 86	0.991 61
.6	0.990 05	0.991 07	0.991 79
.8	0.990 28	0.991 28	0.991 98
12.0	0.990 51	0.991 48	0.992 17
.2	0.990 74	0.991 69	0.992 36
.4	0.990 97	0.991 90	0.992 55
.6	0.991 20	0.992 11	0.992 74
.8	0.991 43	0.992 31	0.992 93
13.0	0.991 67	0.992 52	0.993 12
.2	0.991 90	0.992 73	0.993 31
.4	0.992 13	0.992 94	0.993 50
.6	0.992 36	0.993 15	0.993 69
.8	0.992 59	0.993 35	0.993 89
14.0	0.992 82	0.993 56	0.994 08
.2	0.993 05	0.993 77	0.994 27
.4	0.993 28	0.993 98	0.994 46
.6	0.993 52	0.994 19	0.994 65
.8	0.993 75	0.994 40	0.994 84
15.0	0.993 98	0.994 61	0.995 03
.2	0.994 21	0.994 81	0.995 22
.4	0.994 45	0.995 02	0.995 41
.6	0.994 68	0.995 23	0.995 61
.8	0.994 91	0.995 44	0.995 80
16.0	0.995 15	0.995 65	0.995 99
.2	0.995 38	0.995 86	0.996 18
.4	0.995 61	0.996 07	0.996 37
.6	0.995 85	0.996 28	0.996 57
.8	0.996 08	0.996 49	0.996 76
17.0	0.996 32	0.996 70	0.996 95
.2	0.996 55	0.996 91	0.997 14
.4	0.996 79	0.997 12	0.997 33
.6	0.997 02	0.997 33	0.997 53
.8	0.997 25	0.997 54	0.997 72
18.0	0.997 49	0.997 75	0.997 91
.2	0.997 72	0.997 96	0.998 11
.4	0.997 96	0.998 17	0.998 30
.6	0.998 20	0.998 38	0.998 49
.8	0.998 43	0.998 59	0.998 69
19.0	0.998 67	0.998 80	0.998 88
.2	0.998 90	0.999 01	0.999 07
.4	0.999 14	0.999 22	0.999 27
.6	0.999 38	0.999 43	0.999 46
.8	0.999 61	0.999 64	0.999 66

t °C	Benzene	Toluene	Xylene
20.0	0.999 85	0.999 85	0.999 85
.2	1.000 09	1.000 06	1.000 04
.4	1.000 32	1.000 27	1.000 24
.6	1.000 56	1.000 48	1.000 43
.8	1.000 80	1.000 69	1.000 63
21.0	1.001 04	1.000 91	1.000 82
.2	1.001 27	1.001 12	1.001 02
.4	1.001 51	1.001 33	1.001 21
.6	1.001 75	1.001 54	1.001 41
.8	1.001 99	1.001 75	1.001 60
22.0	1.002 23	1.001 96	1.001 80
.2	1.002 47	1.002 18	1.001 99
.4	1.002 71	1.002 39	1.002 19
.6	1.002 94	1.002 60	1.002 38
.8	1.003 18	1.002 81	1.002 58
23.0	1.003 42	1.003 02	1.002 78
.2	1.003 66	1.003 24	1.002 97
.4	1.003 90	1.003 45	1.003 17
.6	1.004 14	1.003 66	1.003 36
.8	1.004 38	1.003 87	1.003 56
24.0	1.004 62	1.004 09	1.003 76
.2	1.004 86	1.004 30	1.003 95
.4	1.005 11	1.004 51	1.004 15
.6	1.005 35	1.004 72	1.004 35
.8	1.005 59	1.004 94	1.004 54
25.0	1.005 83	1.005 15	1.004 74
.2	1.006 07	1.005 36	1.004 94
.4	1.006 31	1.005 58	1.005 13
.6	1.006 55	1.005 79	1.005 33
.8	1.006 80	1.006 00	1.005 53
26.0	1.007 04	1.006 22	1.005 73
.2	1.007 28	1.006 43	1.005 92
.4	1.007 52	1.006 65	1.006 12
.6	1.007 77	1.006 86	1.006 32
.8	1.008 01	1.007 07	1.006 52
27.0	1.008 25	1.007 29	1.006 72
.2	1.008 50	1.007 50	1.006 91
.4	1.008 74	1.007 72	1.007 11
.6	1.008 98	1.007 93	1.007 31
.8	1.009 23	1.008 14	1.007 51
28.0	1.009 47	1.008 36	1.007 71
.2	1.009 72	1.008 57	1.007 91
.4	1.009 96	1.008 79	1.008 11
.6	1.010 21	1.009 00	1.008 31
.8	1.010 45	1.009 22	1.008 50
29.0	1.010 69	1.009 43	1.008 70
.2	1.010 94	1.009 65	1.008 90
.4	1.011 19	1.009 86	1.009 10
.6	1.011 43	1.010 08	1.009 30
.8	1.011 68	1.010 29	1.009 50

Table 3. Multiplication factors (M_3) for conversion of corrected hydrometer reading at t °C to density at 20 °C (see B.3.3)

t °C	Benzene	Toluene	Xylene
10.0	0.988 57	0.989 76	0.990 63
.2	0.988 80	0.989 96	0.990 82
.4	0.989 02	0.990 17	0.991 00
.6	0.989 24	0.990 37	0.991 19
.8	0.989 47	0.990 57	0.991 37
11.0	0.989 69	0.990 78	0.991 56
.2	0.989 92	0.990 98	0.991 74
.4	0.990 14	0.991 18	0.991 93
.6	0.990 37	0.991 19	0.992 11
.8	0.990 60	0.991 59	0.992 30
12.0	0.990 82	0.991 79	0.992 48
.2	0.991 05	0.992 00	0.992 67
.4	0.991 27	0.992 20	0.992 85
.6	0.991 50	0.992 40	0.993 04
.8	0.991 73	0.992 61	0.993 23
13.0	0.991 95	0.992 81	0.993 41
.2	0.992 18	0.993 02	0.993 60
.4	0.992 41	0.993 22	0.993 79
.6	0.992 64	0.993 42	0.993 97
.8	0.992 86	0.993 63	0.994 16
14.0	0.993 09	0.993 83	0.994 34
.2	0.993 32	0.994 04	0.994 53
.4	0.993 55	0.994 24	0.994 72
.6	0.993 77	0.994 44	0.994 91
.8	0.994 00	0.994 65	0.995 09
15.0	0.994 23	0.994 85	0.995 28
.2	0.994 46	0.995 06	0.995 47
.4	0.994 69	0.995 26	0.995 66
.6	0.994 92	0.995 47	0.995 84
.8	0.995 15	0.995 67	0.996 03
16.0	0.995 38	0.995 88	0.996 22
.2	0.995 61	0.996 08	0.996 41
.4	0.995 84	0.996 29	0.996 60
.6	0.996 07	0.996 50	0.996 78
.8	0.996 30	0.996 70	0.996 97
17.0	0.996 53	0.996 91	0.997 16
.2	0.996 76	0.997 11	0.997 35
.4	0.996 99	0.997 32	0.997 54
.6	0.997 22	0.997 52	0.997 73
.8	0.997 45	0.997 73	0.997 92
18.0	0.997 68	0.997 94	0.998 10
.2	0.997 91	0.998 14	0.998 29
.4	0.998 14	0.998 35	0.998 48
.6	0.998 37	0.998 55	0.998 67
.8	0.998 61	0.998 76	0.998 86
19.0	0.998 84	0.998 97	0.999 05
.2	0.999 07	0.999 17	0.999 24
.4	0.999 30	0.999 38	0.999 43
.6	0.999 53	0.999 59	0.999 62
.8	0.999 77	0.999 79	0.999 81

t °C	Benzene	Toluene	Xylene
20.0	1.000 00	1.000 00	1.000 00
.2	1.000 23	1.000 21	1.000 19
.4	1.000 47	1.000 41	1.000 38
.6	1.000 70	1.000 62	1.000 57
.8	1.000 93	1.000 83	1.000 76
21.0	1.001 17	1.001 04	1.000 95
.2	1.001 40	1.001 24	1.001 14
.4	1.001 64	1.001 45	1.001 33
.6	1.001 87	1.001 66	1.001 52
.8	1.002 10	1.001 87	1.001 72
22.0	1.002 34	1.002 07	1.001 91
.2	1.002 57	1.002 28	1.002 10
.4	1.002 81	1.002 49	1.002 29
.6	1.003 04	1.002 70	1.002 48
.8	1.003 28	1.002 91	1.002 67
23.0	1.003 51	1.003 11	1.002 87
.2	1.003 75	1.003 32	1.003 06
.4	1.003 99	1.003 53	1.003 25
.6	1.004 22	1.003 74	1.003 44
.8	1.004 46	1.003 95	1.003 63
24.0	1.004 69	1.004 16	1.003 83
.2	1.004 93	1.004 37	1.004 02
.4	1.005 17	1.004 57	1.004 21
.6	1.005 40	1.004 78	1.004 40
.8	1.005 64	1.004 99	1.004 60
25.0	1.005 88	1.005 20	1.004 79
.2	1.006 12	1.005 41	1.004 98
.4	1.006 35	1.005 62	1.005 18
.6	1.006 59	1.005 83	1.005 37
.8	1.006 83	1.006 04	1.005 56
26.0	1.007 07	1.006 25	1.005 76
.2	1.007 31	1.006 46	1.005 95
.4	1.007 54	1.006 67	1.006 14
.6	1.007 78	1.006 88	1.006 34
.8	1.008 02	1.007 09	1.006 53
27.0	1.008 26	1.007 30	1.006 73
.2	1.008 50	1.007 51	1.006 92
.4	1.008 74	1.007 72	1.007 12
.6	1.008 98	1.007 93	1.007 31
.8	1.009 22	1.008 14	1.007 50
28.0	1.009 46	1.008 35	1.007 70
.2	1.009 70	1.008 56	1.007 89
.4	1.009 94	1.008 77	1.008 09
.6	1.010 18	1.008 98	1.008 28
.8	1.010 42	1.009 19	1.008 48
29.0	1.010 66	1.009 40	1.008 67
.2	1.010 90	1.009 61	1.008 87
.4	1.011 15	1.009 82	1.009 06
.6	1.011 39	1.010 04	1.009 26
.8	1.011 63	1.010 25	1.009 46
30.0	1.011 87	1.010 46	1.009 65