BF_3-Methanol, 10% w/w

Product Specification

At one time diazomethane and other diazoalkanes were popular reagents for esterification, but their use has diminished because of the explosion hazards and carcinogenicity of these materials. Boron trichloride and boron trifluoride are now the popular esterification reagents. Under very mild conditions, reagents consisting of boron trihalide in 2-chloroethanol, methanol, or butanol readily form esters of aliphatic and aromatic acids, including certain hindered structures, without altering relatively labile structures. The reaction is nearly instantaneous in many cases, and requires only a few minutes reflux in other cases.*

BF_3-Methanol, 10% w/w (10% boron trifluoride in methanol) is particularly useful for preparing methyl esters of carboxylic acids and esters (C8-C24 chain length). When the reagent and sample are heated in a sealed vessel for a short time, the analytes are combined with the anhydrous alcohol (methanol) in the presence of the acid catalyst (BF_3). In the reaction, the analyte and alcohol molecules are joined with a loss of water. The derivatives can be quickly and easily recovered, quantitatively, from the esterification medium and analyzed by GC.

Applications/Benefits

Used for derivatizing C8-C24 carboxylic acids and transesterifying esters.

Convenient, fast, quantitative esterification/transesteri-fication.

Clean reaction (no side reactions) with volatile by-products.

Derivatives are easily and quantitatively isolated.

Typical Procedure

This procedure is intended to be a guideline and may be adapted as necessary to meet the needs of a specific application. Always take proper safety precautions when using an esterification reagent – consult MSDS for specific handling information.

Prepare a reagent blank (all components, solvents, etc., *except sample*), following the same procedure as used for the sample.

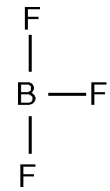
1. Weigh 1-25mg of sample (acid) into a 5mL reaction vessel. If appropriate, dissolve sample in nonpolar organic solvent (e.g., hexane, ether, toluene). If sample is in aqueous solution, evaporate to dryness, then use neat or add organic solvent.
2. Add 2mL BF_3-methanol, 10% w/w. A water scavenger (e.g., 2,2-dimethoxypropane) can be added at this point. (Water can prevent the reaction from going to completion, producing low yields.)
3. Heat at 60°C for 5-10 minutes. Cool, then add 1mL water and 1mL hexane.
4. Shake the reaction vessel – it is critical to get the esters into the nonpolar solvent.
5. Carefully remove the upper (organic) layer, and dry it over anhydrous sodium sulfate.
6. To determine when derivatization is complete, analyze aliquots of the sample at selected time intervals until no further increase in product peak(s) is observed.

   Derivatization times vary widely, depending upon the specific compound(s) being derivatized. If derivatization is not complete, use additional reagent (excess of methanol is needed, relative to the acid or ester) or reevaluate temperature/time.

Properties

Boron Trifluoride

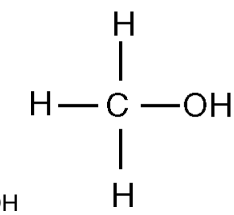
Structure:



CAS Number: 7637-07-2
Molecular Formula: BF_3
Formula Weight: 67.82
bp: -100.4°C
Appearance: colorless gas with pungent odor

Methanol

Structure:



CAS Number: 67-56-1
Molecular Formula: CH_3OH
Formula Weight: 32.04
bp: 64.7°C
Flash Point: 52°F (11°C)
d: 0.791
n_D: 1.3290 at 20°C
Appearance: clear colorless liquid

796-0597, 0598

* Esterification is best in the presence of a volatile catalyst, which subsequently can be removed along with excess alcohol. In addition to boron trichloride and boron trifluoride, typical catalysts are hydrogen chloride (favored because of its acid strength and ready removal at the end of the reaction), sulfuric acid (less easily removed and has dehydrating reactions, charring effects, and/or oxidative side reactions), trifluoroacetic and dichloroacetic acids, benzene- and p-toluene-sulfonic acids, sulfuryl and thionyl chlorides, phosphorus trichloride and oxychloride, and polyphosphoric acids. The catalyst must be chosen with care to avoid isomerization and artifact production with unsaturated or cyclopropane-substituted acids. One of the main advantages of BF_3 over other fluorinated catalysts is that it does not produce fluoroanhydrides on acylation with acid anhydrides and does not form HF when phenols or alkyl ethers of phenols are acylated by acids.

Alternatively, analytes can be esterified with more reactive acid anhydrides or chlorides, for which no catalyst is required.

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Mechanism (1,2,3)

Esterification

$$\text{R-COOH} + CH_3OH \xrightarrow{\text{acid } (BF_3)} \text{R-COO-}CH_3 + H_2O$$

Adapted from (1).

Esterification involves heating the carboxylic acid with an acid catalyst in an alcohol solvent. The catalyst protonates an oxygen atom of the COOH group, making the acid much more reactive to nucleophiles. An alcohol molecule (CH_3OH) then combines with the protonated acid, to yield the ester product (R-COO-CH_3) with loss of water. Esterification is a reversible reaction. Water must be removed to drive the reaction to the right and obtain a high ester yield. A chemical reagent can be used to remove water as it is formed or, if the reaction is conducted at a temperature above 100°C, water may distill off as it is formed. 2,2-dimethoxypropane can be introduced into the reaction mixture to react with the water, yielding acetone. Other water scavengers are anhydrous sulfuric acid and graphite bisulfate.

Transesterification

$$\text{R-COOR'} + CH_3OH \xrightarrow{\text{acid } (BF_3)} \text{R-COO-}CH_3 + \text{R'-OH}$$

Adapted from (3).

In transesterification, the alcohol is displaced from the ester by another alcohol (e.g., methanol) in a process similar to hydrolysis (the second alcohol is used instead of water), forming a new ester. Transesterification also is an equilibrium reaction. To shift the reaction to the right, it is necessary to use a large excess of the second alcohol, or to remove one of the products from the reaction mixture. The stoichiometry of the reaction requires 3 moles of alcohol for each mole of triglyceride. Conversion is maximized if excess alcohol is used. The conversion rate also is influenced by the reaction temperature – the reaction generally is conducted near the boiling point of the alcohol.

Toxicity - Hazards - Storage - Stability

BF_3-methanol is a flammable, toxic liquid. It may irritate eyes, skin, and/or the respiratory system. Recommended storage conditions for the unopened product are stated on the label. Store opened reagent in a sealed bottle or ampul. **If you store an opened container or transfer the contents to another container for later reuse validate that your storage conditions adequately protected the reagent**.

Use only in a well ventilated area and keep away from ignition sources. Moisture can hinder the reaction – it may be necessary to dry the solvents before conducting the reaction.

The reagent has a limited shelf-life, even when refrigerated, and the use of old or excessively concentrated solutions (through alcohol evaporation) often produces artifacts and a significantly lower reaction yield.

Ordering Information:

BF_3-Methanol, 10% w/w

20 x 1mL	**33356**
19 x 2mL	**33020-U**
10 x 5mL	**33040-U**
400mL	**33021**

Micro Reaction Vessels with Hole Caps and Septa

pk. of 12

1mL	**33293**
3mL	**33297**
5mL	**33299**

Books

Handbook of Derivatives for Chromatography K. Blau and J. Halket	**26566-U**
Handbook of Analytical Derivatization Reactions D.R Knapp	**23561**

Additional Reading

R. Kleiman, G.F. Spencer, F.R. Earle *Boron Trifluoride as Catalyst to Prepare Methyl Esters From Oils Containing Unusual Acyl Groups* Lipids, **4 (2):** 118-122 (1968).

E.S. Woodbury, P.R. Evershed, J.B. Rossell, R.E. Griffith, P. Farnell *Detection of Vegetable Oil Adulteration Using Gas Chromatography Combustion-Isotope Ratio Mass Spectrometry* Anal. Chem., **67:** 2685-2690 (1995).

R.M. Le-Lacheur, L.B. Sonnenberg, P.C. Singer, R.F. Christman, M.J. Charles *Identification of Carbonyl Compounds in Environmental Samples* Environ. Sci. Technol., **27:** 2745-2753 (1993).

X. Yan, P.J. Barlow, C. Craven *Discrimination in Recovery During Capillary GLC Analysis of Fish Oil: The Use of a Recovery Correction Factor* Food Chem., **40 (1):** 93-99 (1991).

References

1. K. Blau and J. Halket *Handbook of Derivatives for Chromatography* (2nd ed.) John Wiley & Sons, New York, 1993.
2. D.R. Knapp *Handbook of Analytical Derivatization Reactions* John Wiley & Sons, New York, 1979.
3. *Bailey's Industrial Oil and Fat Products*, fifth edition, Vol. 5, John Wiley & Sons, New York (1995).

References not available from Supelco.

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