

# RETURN LINE TREATMENTS

## Meeting Shipping and Storage Requirements

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For many years, Scranton Associates and its precursor has produced many return line treatments for many customers. We have often been asked for guidance as to the flammability of these end products. Typically they have been dilutions and/or combinations of diethylaminoethanol (DEAE), morpholine (MOR), and cyclohexylamine (CHA). Other materials such as aminomethylpropanol (AMP), triethanolamine (TEA), methoxypropylamine (MOPA), and dimethylamino-2-propanol (DMA-2-P) are used to a lesser degree, but will not be part of this article.

According to the DOT, cyclohexylamine, morpholine, and diethylaminoethanol are all flammable in their undiluted form since their flash points are all under 141° F. The concentrations of return line treatments typically provided to the consumer run from about 10% to 30% active. Amine manufacturers have flash point data for their full strength materials, and for some of the high concentrations, but information has not been readily available for the dilutions and combinations commonly used in boiler water treatment. Anyone who markets these products needs to be sure that they are shipped and stored properly.

In the past, we did our best to provide guidance as to the flammability of various return line treatments. Our estimates were based on the data we had available at the time, and because these figures were estimates only, our suggestions tended to be very conservative.

Recently one of our neighbors in the oil industry offered to run Pensky-Martens closed cup flash point tests for us at a very reasonable cost. This was the perfect opportunity for us to more precisely determine flash points for various amine dilutions, and to determine which ones would need to be shipped as "flammable". A summation of this information is provided in Table I.

**Table I**  
**Combustibility/Flammability of Amines and Amine Dilutions**

<i>Aqueous Solutions</i>	<b>&lt; 141° F</b> DOT <i>Flammable</i>	<b>141°-200° F</b> DOT <i>Combustible</i>	<b>&gt;200° F</b> DOT <i>Non-Combustible</i>
<b>Diethanolamine (DEAE)</b> Flash Point 100% = 125° F	<b>90-100%</b>	<b>80-90%</b>	<b>0-80%</b>
<b>Morpholine (MOR)</b> Flash Point 100% = 98° F	<b>70-100%</b>	<b>35-70%</b>	<b>0-35%</b>
<b>Cyclohexylamine (CHA)</b> Flash Point 100% = 83° F	<b>50-100%</b>	<b>0-50%</b>	<b>Not Possible</b>

The DOT considers anything with a flash point of 141° F, or less, to be flammable. NFPA, insurance companies, and fire departments still consider that only products with flash points of less than 100° F are flammable. In general, combustible materials would have a flash point of over 141° F, but less than 200° F.

Products classified as combustible (as opposed to flammable), are not regulated by the DOT unless shipped in containers of 110, or more, gallons. No “combustible” labels are required for 55 gallon drums, or smaller containers. Containers of over 110 gallons (totes), and bulk shipments, of combustible products are DOT regulated and, as such, require the appropriate “combustible” placards and Proper Shipping Name (PSN) descriptions.

Flammable and combustible materials must be stored in accordance with NFPA Code 30 which (depending on quantity involved) may require a separate flammable/combustible storage room.

The DOT requires that products be tested to determine flammability, or more typically tested to determine corrosivity, and the appropriate packing group (PG).

For aqueous dilutions of a single amine, having a flash point of over 141° F, no recognition of flammability is necessary, and the following Proper Shipping Names (PSNs) would apply. For all three of these amines, the primary hazard is corrosivity.

*2-diethylaminoethanol solution, 8, UN 2686, PG II*  
*morpholine solution, 8, UN 2054, PG I (or II if 40% or less).*  
*cyclohexylamine solution, 8, UN 2357, PG II.*

For flammable concentrations of these amines (as shown in Table I), a subsidiary flammable label, as well as the addition of the subsidiary flammable class “(3)” to the PSN, is required. Should the concentration of amine be quite low, testing may indicate that a Packing Group III is acceptable, but this might result in products too dilute to be practical.

We also decided to test a few amine blends since many return line treatments are combinations of two, and sometimes three amines. Since there are an infinite number of possible combinations, we chose a few that seemed to be fairly representative of products in common use.

An aqueous solution of about 13%, or less, of each CHA and MOR would have a flash of over 141° F, would not be "flammable", and would be shipped as: *corrosive liquid, basic, organic, nos, (cyclohexylamine, morpholine), 8, UN 3267, PG II*

A formula with the same 13% each of DEAE, MOR, and CHA would also have a flash of over 141° F, and would also not be considered "flammable". The PSN is the same as for the MOR and CHA dilution above since a maximum of only two materials is allowed in the parenthesis of any PSN.

The data we have indicates that the flash point of a mixture containing CHA can never exceed 200° F, regardless of concentration. As a result, totes or bulk shipments, containing CHA must always ship as either "flammable" or "combustible".

CHA is also an EPA *Extremely Hazardous Substance* (EHS) with a *Reportable Quantity* (RQ) of 10,000 lbs. This "RQ" designation must be shown on the shipping papers for any bulk shipment containing 10,000 lbs., or more, of CHA.

Morpholine was recently reclassified as a Packing Group (PG) I. PG I materials must be shipped in an "x" rated drum. Drums typically in use are "y" rated, and are approved for PG II and III products only. If the morpholine concentration is kept below 40%, "y" rated drums are acceptable, and a Packing Group II could be used in the PSN. Our testing was intended to determine at what concentration formulas would need to be shipped as flammable. As a result, we did not have any testing done to determine at what concentration formulas would no longer be combustible (with a flash of over 200 F). According to our existing data, a 35% solution of morpholine should have a flash of over 200 F making it non-combustible. We did not, however, have any tests performed on morpholine, at this concentration, to verify this information.

In general, products that do not need to be shipped as flammables will be more favorably received by your customers. Hopefully the information presented in this article will allow you to formulate Return Line Treatment products that, while still highly active and effective, will not need to be labeled, shipped or handled as flammables.