Details on the darkening of fuel from Thermax

This darkening effect is noted in the final notes of the Dry Wash Tower Users Manual.

The specific reasons for this color change are explained as follows:

While saturated aliphatic hydrocarbons do not react with strongly acidic cation exchange resin, unsaturated aliphatic hydrocarbons can.

These are the common unsaturated fatty acids potentially in biodiesel (methyl-ester or fatty acid methyl ester) :

Myristoleic acid	$CH_3(CH_2)_3CH=CH(CH_2)_7COOH$	cis-Δ^9	14:1 n–5
Oleic acid	$CH_3(CH_2)_7CH=CH(CH_2)_7COOH$	cis-Δ^9	18:1 n–9
Palmitoleic acid	$CH_3(CH_2)_5CH=CH(CH_2)_7COOH$	cis-Δ^9	16:1 n–7
Sapienic acid	$CH_3(CH_2)_8CH=CH(CH_2)_4COOH$	cis-Δ^6	16:1 n–10 n–6
Linoleic acid	$CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOH$	cis,cis-Δ^9,Δ^{12}	18:2

Unsaturated Methyl Ester molecules are alkylated in the presence of low-molecular-weight alkenes (unsaturated hydrocarbons or small chained FFA's or carbonic acids) in the presence of a strong acid cation ion exchange resin (alkylated). And any impurities can be sulfunated.

So the longer the residence time in the ion exchange column the greater the chance that alkylation or sulfunation will occur that is why we recommend a 20 minute residence time and stress the use of proper flow rates (it is possible that during the initial uses of the column to speed up processing due to the high strength of the ion exchange resin because it is brand new).

However even at the proper flow rates some amount of color change is expected and should occur as an indication that the ion exchange process is still working properly.

The high temperature use of cooking oils has degraded the triglycerides producing both longer hydrocarbon chains and shorter hydrocarbon FFA molecules therefore the methyl ester molecules created from these FFA's are more susceptible to alkylation thus the color change.

Further, although a good biodiesel production process shouldn't have "impurities" it is possible if the biodiesel is sent too rapidly to the ion exchange column, that some glycerin still dissolved in the residual methanol may contain these impurities from used cooking oil.

These impurities can react with a strongly acidic ion exchange resin (sulfunation) and cause color changes.

The color changes due to Alkylation do not effect fuel quality and in the petro industry alkylation is actually used to create a higher grade, cleaner burning fuel additive.

Sulfunation on the other hand can result in higher sulfur content and in some cases produce non-ASTM fuel and we have seen this with some producers but they were able to correct this by eliminating the impurities prior to ion exchange resin processing...

Lastly, we have seen cases where users (including ourselves) let the biodiesel reside in a column of ion exchange resin for several days resulting in what we called "burned fuel" because it was extremely dark and nontransparent. This fuel was sampled and sent off to a lab for testing and although I wouldn't use it in my vehicle, it did pass the top five biodiesel fuel analyses. We chose to blend this fuel back into our larger batches and reprocess. Over time we did use all this fuel.