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Correlations For Estimating Diesel Oil Properties from Component Data

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ABSTRACT

Diesel oil stocks obtained from light and heavy Saudi Arabian crude oils were analyzed for their physical properties. By blending these component stocks in various ratios, final diesel oil products were obtained and correlations for the prediction of properties of final blends were developed with the help of multiple analysis technique on component data. The results produced from these correlations were compared with the actual laboratory data and good agreements supporting the correlations were observed.

Key Words: *Diesel oil, flash point, pour point, viscosity, diesel ındex*

Bileşenler Verilerinden Dizel Yakıtları Özelliklerini Hesaplayan Korrelasyonlar

ÖZET

Hafif ve ağır Suudi Arabistan ham petrollerinden elde edilen temel ana ürünler, fiziksel özellikleri için analiz edildi. Bu ana temel ürünler değişik oranlarda paçallanarak, nihai dizel ürünler elde edildi ve bileşen verileri üzerinde matematiksel yöntemler uygulanarak nihai ürünlerin özelliklerini saptayan korrelasyonlar oluşturuldu. Bu korrelasyonlardan elde edilen neticeler, gerçek laboratuar verileri ile karşılaştırıldı ve korrelasyonları doğrulayan uygun ve iyi neticeler gözlendi.

INTRODUCTION

Diesel oils are the fuels used for their particulat type of engines (1). As finished products, they have their own properties they are obtained by blending corresponding stoks whih are produc- ed from the fractional distillation of crude oils. It is very important in the field of petroleum industry to estimate the physical properties of diesel oils, namely, specific gravity (SG), kinematic viscosity (KV), flash point (FPT), pour point (PPT), diesel index (DI) and certain AST distillation temperatures from blend component data so that they meet with already estblished standards (2). Both specific grvity or API (American Petroleum Institute) gravity are useful for weight and volume computations also closely related to heating value of an oil (3). The most convenient way to express specific gravity is the form of degrees of API:

API=(141.5 / SG) – 131.5

As regard diesel engines, viscosity indicates the ability of the fuel to flow in the fuel system and also determines the lubricating value needed to lubricate the fuel pump and injector. Viscosity also affects the pattern of the oil spray in the safety aspects of fuel handling and how an oil will ignite in a diesel cylinder. Pour point indicates the suitablity of the oil for cold weather operation. Diesel index (DI) is an indication of the quality of a diesel fuel and can be formulated as follows (4):

DI=(Aniline point 'F'xAPI) /100

Aniline point is the lowest temperature at which the oil sample is completely miscible with an equal volume of aniline (5). A fuel is said to have high ignition quality when will self-ignite at a low temperature; and fuel of high ignition quality requires little time to vaporize and attain combustion within a diesel engine (6). For distillation mainly 10% and 50% vaporization temperatures (T10% and T50%) are important for easy starting, adequate warming up and good acceleration purposes (7). The analysis of the diesel oil blending (or component) stocks obtained from heavy (H) and light (L) Arabian crude oils are given in Table (1), also the analysis of the blends obtained from these stocks are given in Tables (2) and (3).

Table 1. Analysis of Oil Blending Stocks

Test Name	Heavy. Arab Kerosin	Heavy. Arab Gas Oil	Light Arab Kerosine	Light Arab Gas Oil	Heavy Arab V.G.O.	Light Cycle Oil (L.C.O.)
S.G.@60/60 F	0.8036	0.8414	0.7996	0.8304	0.8953	0.9220
API @ 60 F	-	-	-	-	-	-
KV @ 40 C, cst	1.7	3.8	1.5	2.8	18.68	2.67

Table 2. Analysis of Blends with Four Components Variables (Light Arab)

Blend No	1	2	3	4	5	6	7	8	9	10
% L.A Kerosine	10	15	15	20	20	30	30	40	40	10
% L.A Gas Oil	70	70	70	60	60	50	50	40	40	10
% V.G.O.	15	10	5	15	10	15	10	15	10	20
% L.C.O.	5	5	10	5	10	5	10	5	10	10

Table 3. Analysis of Blends with Four Components Variables (Heavy Arab)

Blend No	1	2	3	4	5	6	7	8	9	10
% H.A Kerosine	10	15	15	20	20	30	30	40	40	10
% H.A Kerosine	70	70	70	60	60	50	50	40	40	60
% V.G.O.	15	10	5	15	10	15	10	15	10	20
% L.C.O.	5	5	10	5	10	5	10	5	10	10

DISCUSSION:

As known, regression analysis is a modelling technique that allows us to relate a dependent variable to one or more independent variables throughout the best fitting equation. The depend ent varibles are the composite blends properties and independent variables are the values of the blending stocks properties multiplied by their volume fractions. Subscripts 1, 2, 3, and 4 are used for denoting properties of kerosene, gas oil, Fluid Catalytic Cracking Unit (FCCU) cycle-oil and vacuum gas oil (VGO) respectively.

The results obtained from the regression analysis of blends having the before mentioned components originating from light and heavy diesel oils can be summarized as correlations for quick and speedy calculation purposes in the following ways:

For diesel oil from light Arabian crude oil:

SG=1.00311xSG(1)+0.997677xSG(2)+1.004549xSP(3)+1.006044xSP(4)

API=0.980078xAPI(1)+1.008889xAPI(2)+0.945683xAPI(3)+0.886651xAPI(4)

KV=0.909741xKV(1)+0.927855xKV(2)+0.335015xKV(3)+0.800386xKV(4)

FPT=0.962208xFPT(1)+0.856853xFTP(2)+0.864934xFPT(3)+1.099042xFPT(4)

PPT=0.0642047xPPT(1)+0.401923xPPT(2)+0.618652xPPT(3)+1.460761xPPT(4)

DI=0.990993xDI(1)+1.010609xDI(2)+1.021024xDI(3)+0.412804xDI(4)

T10%=0.97962xT10%(1)+0.99164xT10%(2)+0.82312xT10%(3)+0.88216xT10%(4)

T50%=0.99096xT50%(1)+1.02234xT50%(2)+0.85031xT50%(3) +0.91456xT50%(4)

The estimated blend values were compared with those experimental ones. Table (4) shows the comparison of estimated specific gravity (SG) values with those of experimental ones. The last column of Table 4 shows the percent absolute deviation, where its average value is 0.045 percent. It was found that average absolute deviation was always less than 5 percent except the pour point case. For diesel oil from the heavy Arabian crude oil:

SG=1.00788xSG(1)+0.997267xSG(2)+1.00742xSG(3)+0.998165xSG(4)
API=0.962223xAPI(1)+1.011835xAPI(2)+0.9324xAPI(3)+0.962048xAPI(4)
KV=0.813749xKV(1)+0.912707xKV(2)+0.3783xKV(3)+0.636683xKV(4)
FPT=0.921411xFPT(1)+0.849362xFPT(2)+0.945252xFPT(3)+1.019173xFPT(4)
PPT=0.0626779xPPT(1)+0.54231xPPT(2)+1.624678xPPT(3)+1.049815xPPT(4)
DI=1.013341xDI(1)+0.969783xDI(2)+1.101225xDI(3)+1.243112xDI(4)
T10%=0.90941xT10%1)+0.97689xT10%(2)+0.870525xT10%(3)+ 0.911548xT10%(4)
T50%=0.99104xT50%(1)+1.0111xT50%(2)+0.897897xT50%(3)+0.876848xT50%(4)

CONCLUSION:

Good results were obtained in the prediction of specific gravity (or API), kinematic viscosity, flash point, pour point, diesel index and temperatures of 10% and 50% distillation points which hare the typical physical properties of diesel oils, by using component data for blending stocks obtained from the light and heavy Arabian crude oils through the correlations developed in this work. Consequently, the developed correlations can be recommended for use in predict- ing the mentioned properties in refinery operations.

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