UDC 629.7.621.892

DEVELOPMENT AND APPROVAL OF A NEW METHOD FOR DETERMINING WATER CONTENT IN DIESEL FUEL WITH USAGE INNOVATIVE TECHNOLOGIES

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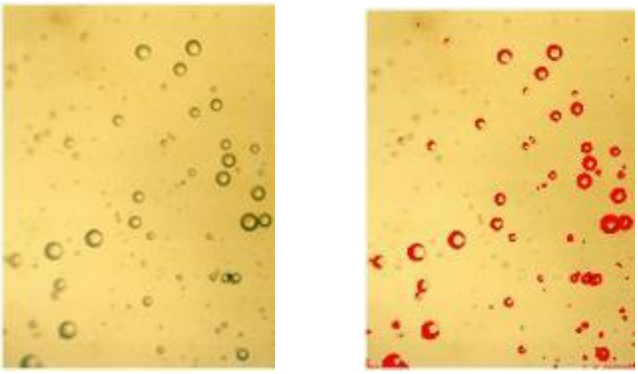
Monitoring water content in diesel fuel is crucial for maintaining its high quality and ensuring reliable engine performance. The use of ImageJ software for analyzing water droplets enables fast and accurate quantitative analysis, construction of size distribution functions, and evaluation of overall water content. This method can be applied in laboratory settings for regular fuel monitoring and preventing degradation caused by water

Water in fuel contributes to the corrosion of the fuel system, reduces lubricating properties, and may lead to equipment failure [1]. Water can enter diesel fuel for various reasons: condensation in fuel tanks, deficiencies in storage and transportation systems, or during refueling. Water in diesel fuel can exist in different forms: dissolved, emulsified, or as free droplets [2]. The emulsified form is particularly dangerous, where water is present as tiny droplets uniformly distributed throughout the fuel. Microscopic analysis is used for precise assessment of water content and the study of droplet sizes.

ImageJ is a free software tool for image processing and analysis widely used in various scientific research fields. Its features allow not only data visualization but also precise measurement of particle sizes and quantitative analysis, making it an ideal tool for analyzing water droplets in diesel fuel.

The study utilized microscopic images [3] of diesel fuel with varying water content (Fig. 1a).



a b

Fig. 1. Microscopic images of diesel fuel with varying water content:
a - before processing in ImageJ; b - after processing in ImageJ.

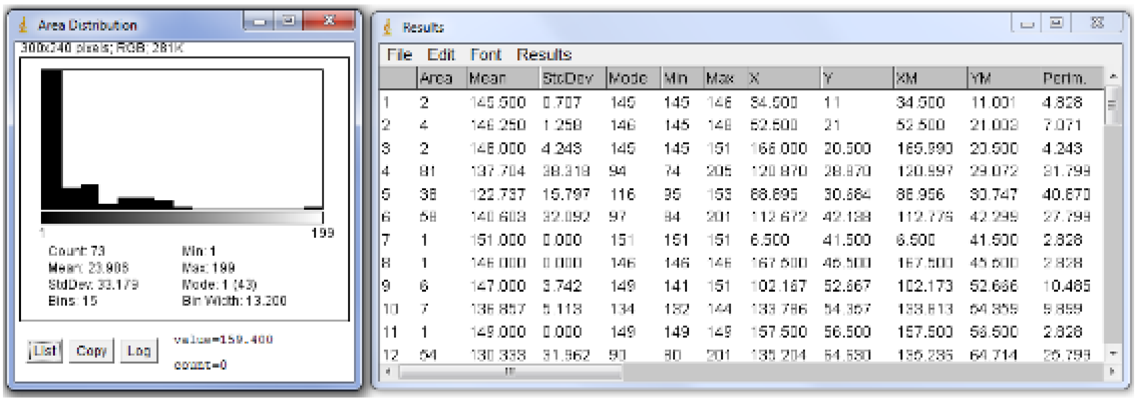
In these images, water droplets appeared as dark circles against the light background of the diesel fuel. After preparing the images (Fig. 2b), the water droplets were automatically counted using the Analysis Particles function in ImageJ:

For particle analysis, the size range of droplets (e.g., 10 to 500 pixels) and particle shape (circularity coefficient from 0.8 to 1.0 to account for only round droplets) needed to be specified.

The software automatically identified and counted all droplets meeting the specified parameters. For each droplet, the program displayed parameters such as area, perimeter, length, and width.

The results for droplet areas were used to create a histogram of the size distribution of water droplets (Fig. 2). The histogram demonstrated the frequency of droplets of various sizes in the fuel. This provides a better understanding of the structure of the water emulsion in the fuel and an evaluation of the contamination level.

The analysis of water droplets in diesel fuel showed that the average droplet size ranged from 50 to 200 µm, depending on the overall water content in the fuel samples. The size distribution histogram revealed that most droplets were smaller than 100 µm, but as the water content increased, the proportion of larger droplets also grew.



	Area	Mean	StdDev	Mode	Min	Max	X	Y	XM	YM	Perim.
1	2	145.500	0.707	145	145	146	34.500	11	34.500	11.001	4.828
2	4	146.250	1.258	146	145	148	52.500	21	52.500	21.003	7.071
3	2	148.000	4.243	145	145	151	166.000	20.500	165.990	20.500	4.243
4	81	137.704	38.318	94	74	205	120.870	28.870	120.997	29.072	31.799
5	38	122.737	15.797	116	95	153	88.895	30.684	88.956	30.747	40.870
6	58	140.603	32.092	97	84	201	112.672	42.138	112.776	42.299	27.799
7	1	151.000	0.000	151	151	151	6.500	41.500	6.500	41.500	2.828
8	1	146.000	0.000	146	146	146	167.500	45.500	167.500	45.500	2.828
9	6	147.000	3.742	149	141	151	102.167	52.667	102.173	52.686	10.485
10	7	136.857	5.113	134	132	144	133.786	54.357	133.813	54.359	9.859
11	1	149.000	0.000	149	149	149	157.500	56.500	157.500	56.500	2.828
12	54	130.333	31.962	90	80	201	135.204	64.580	135.235	64.714	25.799

Fig. 2. Histogram of the size distribution of water droplets.

In samples with higher water content, an increase was observed in both the number of droplets and their average size.

The method of analyzing water droplets using ImageJ has proven to be an effective and accessible tool for assessing the quality of diesel fuel. Its main advantages are its speed and simplicity. Unlike more complex measurement methods, such as chemical analysis or spectrometry, this approach requires only basic equipment (a microscope and camera) and can be implemented in virtually any laboratory.

The limitations of the method include dependence on the quality of the original images and the need for manual adjustment of segmentation parameters to correctly identify droplets. However, with proper preparation, the method allows for accurate data on water content in diesel fuel.

References

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