Filtration of Working Fluid and Reliability of Spray Nozzle Performance

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In our previous article (titled Pesticide nozzles: wear and its consequences), a reference has been made to the Catalogue of the ASJ company, ARAG Group, and, particularly, to the table which illustrates that wear on slit-type spray nozzles may result in as high as a six-fold increase of the non-uniformity of working liquid distribution along the length of the spray boom! Clogged spray nozzles may inflict even more inconsistent results in spraying operations.

So, in case a nozzle gets completely clogged, the whole crop band (swath) may remain untreated or insufficiently treated. Partial clogging in nozzles (see *Photo*) results in occurrence of streaks in the nozzle spray pattern and significantly deteriorates the distribution of the working fluid. Under such circumstances, nozzle malfunction always leads not only to heavy pollution load on the environment, but it also results in serious economic losses to the agricultural production facilities.

The question arises, why is a certain nozzle, having been fitted with only one filling filter and another filter in the line before the pump, capable to perform without a failure, while another nozzle, even though it is incorporated into the 5-7-stage filtration system, has persistent problems of clogging in the tip?

And the answer is quite simple: it all depends on the nozzles. It is basically the nozzle that determines the size of the openings in the filtering elements and the number of filtration stages necessary for the trouble-free performance of the nozzle. International standard ISO 19732 specifies the system of colour coding for identification of all types of filters and the sizes of hole openings in screening elements of filters, as 16; 32; 50; 80; 100; 150; 200 mesh (a mesh denotes the number of wire strands per one linear inch of the weave pattern in screening material). The greater the number of meshes, the smaller the size of the openings is. The size of an individual filter (strainer) is to be determined according to a particular nozzle design. Each prior filter in the sprayer system should have the larger openings and the larger effective area in the filtering element than those in each filter provided downstream. While changing the set of slit-type nozzles for another set of similar nozzles, but intended for a different working fluid rate, it is reasonable to alter, adequately, the number of filters. For example, the replacement of the XR 11003 nozzle model with the XR 11001 model requires upgrading to six stages of filtration instead of the three-stage filtration.

The faultless performance of a pesticide spray nozzle without risk of clogging can be attained, provided the sum of the sizes of three largest solid particles which can penetrate through the filter does not exceed the size of the smallest opening in the spray nozzle (Figure 1).

The information presented in the *Table* below allows a full display of the reason why the sprayers, even though they are provided with a multi-stage filtration system, have persisting failures due to clogging of the slit-type nozzles. The 8th column in the *Table* contains the estimated sizes of the filter mesh sizes for a particular slit-type nozzle, which are estimated with the view to ensure the nozzle trouble-free performance. Comparing these values to those recommended by the manufacturer (the 9th column), it is evident that all these sizes do not correspond to the basic principle of the above mentioned conceptual scheme for the estimation of the necessary level of filtration. For example, in the AI 11003 injector nozzles, the nozzsle opening has an area which is 2.4 times greater than that in the XR 11003 model, but the manufacturer recommends the same level of filtration for both models, which is apparently insufficient for either of these spray nozzles.

Thus, manufacturers of slit-type nozzles have to balance two plausible causes of nozzle failures. One of these causes may be insufficient filtration, which accelerates the wear rate on the spray nozzle and results in the nozzle tip clogging; another cause of the failure may be too small mesh size in filtering elements; and as a consequence, the individual filters get clogged very quickly and prevent the passage of the working fluid into the spray nozzle, or in other words, as the hydraulic resistance of the filter increases, the pressure before the spray nozzle decreases. With any individual filter being clogged, the fluid flow rates in the corresponding spray nozzles may be decreased several-fold! This also may be the cause of further deterioration of non-uniformity in the working fluid distribution across the whole length of the spray boom. Although an individual filter protects the spray nozzle against wear and clogging, it may reduce the efficacy of the spraying operations.

An increase in hydraulic resistance of the filtering elements positioned after the manometer / pressure gauge in the downstream flow of the hydraulic line cannot be controlled. Therefore, on completion of every spraying shift, the only recommendation is to clean all the filtering elements, the individual filters included.

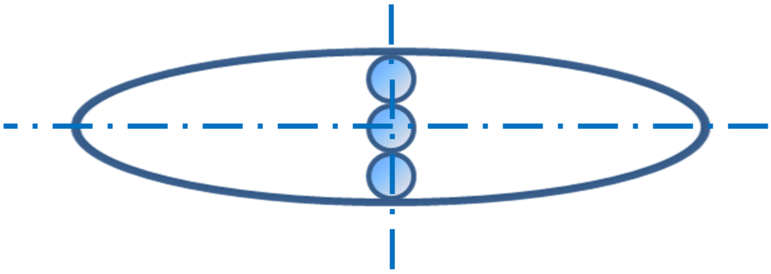
All models of the ROsa centrifugal nozzles have the nozzle diameter of 1.0 mm or greater and that corresponds to the slit-type nozzle of the XR 11010 model with the rated flow of 4.0 L / min, for which the Teejet company do not recommend any individual filters. The anti-clogging effect in the spray nozzle tip of the ROsa centrifugal atomizer is achieved due to the pertinent dimensions and configuration of the flow chamber (Figure 2). Through four channels (A) water passes into the collector (B), wherein the water flow rotates in two planes and then enters the tangenially positioned inlet channels (B); this results in the separation of the solid particles and their hold down to the collector walls (B), wherefrom the particles are gradually washed down and out. The inlet channels (C) in the ROsa atomizer serve as an additional self-cleaning filter for the spray nozzle opening.

Due to comprehensive filtration of the working fluid through 330 µm filter (80 mesh) (exclusive of the individual filters), the clogging of the Rosa centrifugal atomizers with mechanical impurities from the working fluid is effectively prevented, and it makes the nozzle cleaning unnecessary and eliminates the operator’s contact with the pesticide.

Dimensions of the spray nozzle tip openings and screen mesh sizes of individual filters

Nozzle model	Code as per ISO 10625	Fluid flow rate at 0.3 MPa, L/min	Dimensions of nozzle tip openings			Screen mesh sizes of individual filters		
			Length	Width		Estimated values		Recommended sizes,*** mesh
			mm*	mm*	µm	µm	mesh**	
XR 11001	01	0,4	1,14	0,25	250	80	200	100
XR 110015	015	0,6	1,42	0,33	330	110	150	100
AI 110015	015	0,6	2,33	0,58	580	190	150	100
XR 11003	03	1,2	1,97	0,50	500	160	100	50
AI 11003	03	1,2	3,03	0,83	830	270	80	50
XR 11005	05	2,0	2,62	0,67	670	220	100	50
AI 11005	05	2,0	3,64	1,00	1000	330	80	50
XR 11010	10	4,0	3,59	1,00	1000	330	80	
XR 11015	15	6,0	4,04	1,21	1210	400	50	

* According to data presented by H. Guler, H. Zhu, H. Ozkan et al., 2007;
** For stainless steel, colour coding as specified in ISO 19732;
*** Teejet 51-RU Catalogue, colour coding as specified in ISO 19732.



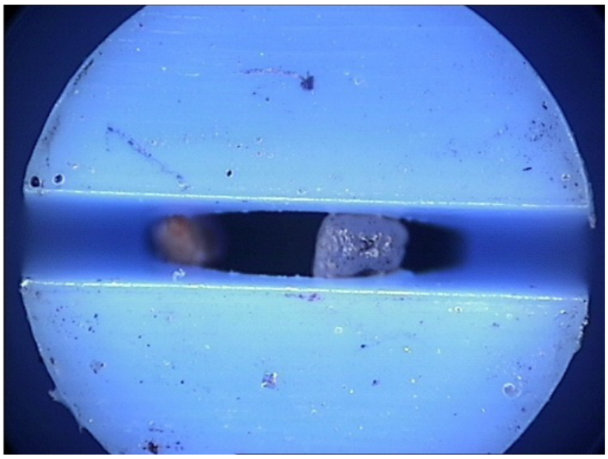


Figure 1. Schematic presentation of estimation of a level of filtration required.

Clogged opening in a slit-type spray nozzle (photo by Lechler company)

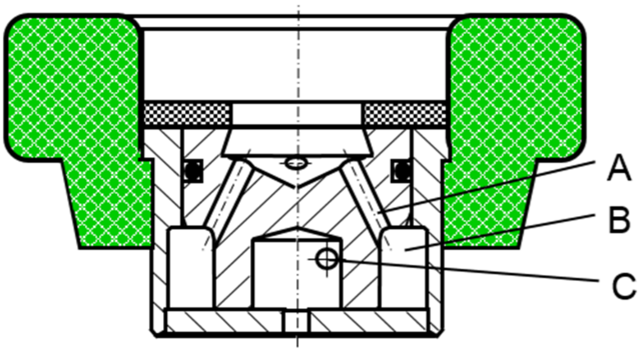


Figure 2. ROsa centrifugal atomizer R.03.0.6