
Guidelines for Use of DAD Series Road Adhesion Agents

The document is applicable to the following grades:

DAD-1 grade "A", DAD-1 grade "C", DAD-K, DAD-K Premium, DAD-M, DAD-KS, DAD-KT

1. Description

DAD agents are intended to be used in road construction as an adhesion agent to bitumens in the preparation of asphalt concrete mixes, where aggregates of acidic and base rock are used.

Package and Storage

The agent is packaged in 218 l metal barrels or drums, 52l metal drums, plastic containers that ensure preservation of the agent weight and properties during transportation and storage.

2. Intended Purpose

DAD-1 is an amphoteric-type adhesion agent used in road construction to improve the adhesion of petroleum road bitumen to aggregates of both acidic and base rock.

DAD-1 is produced in two grades ("A", "C"), that differ in commodity form for easy application under consumer's diverse process conditions, yet have the same chemical effect on bitumens.

DAD-K is a cationic-type adhesion agent used in road construction to improve the adhesion of aggregates to petroleum road bitumens in asphalt concrete mixes containing mainly acidic crushed stone.

DAD-K Premium is a cationic-type adhesion agent used in road construction to improve the adhesion of aggregates to petroleum road bitumens in asphalt concrete mixes containing mainly acidic crushed stone? characterized by a lower concentration of input.

DAD-M - Thermally stable adhesion agent based on fatty acid maleates. The thermal stability is up to five days at 160°C.

DAD-KS is a cationic-type bulk adhesion agent used in road construction to improve the adhesion of aggregates to petroleum road bitumens in asphalt concrete mixes containing mainly acidic crushed stone.

DAD-KT is a thermally stable adhesion agent used in road construction to improve the adhesion of petroleum road bitumen to aggregates of both acidic and base rock, that maintains advanced adhesive properties of hot petroleum bitumens for up to 10 days.

3. Technical Requirements

Parameter description	Indicator value for grade						
	DAD-1 grade A	DAD-1 grade C	DAD-K	DAD-K Premium	DAD-M	DAD-KS	DAD-KT
Type of agent adding	Manual adding	Automatic adding	Manual and automatic adding	Manual and automatic adding	Manual and automatic adding	Manual adding	Manual and automatic adding
Dosage, % by weight of binder	0.3-0.8	0.3-0.8	0.15-0.5	0.1-0.3	0.2-0.8	0.1-0.6	0.1-0.8
Appearance at 20°C	Homogeneous viscous-flow brown liquid	Homogeneous flow brown liquid	Homogeneous viscous-flow light-yellow to dark-brown liquid	Homogeneous viscous-flow light-yellow to dark-brown liquid	Homogeneous viscous-flow brown liquid	Yellow to brown flakes	Homogeneous viscous-flow light-yellow to dark-brown liquid
Max. mass fraction of water and highly volatile substances, mass %	2.0	2.0	0.5	0.5	0.5	0.5	5.0
Max. viscosity as per B3-5 at 60°C	50	35	35	35	35	-	35
Max. acid index, mgKOH/g	-	-	25	25	-	25	200
Max. no-flow point, °C	-	-	minus 2	-	-	-	-
Min. dropping point, °C	-	-	-	-	-	70	-
Adhesion of binder to mix aggregate as per GOST 12801	4 - 5 points	4 - 5 points	4 - 5 points	4 - 5 points	4 - 5 points	4 - 5 points	4 - 5 points
Thermal stability upon continuous heating in bitumen (163 °C)	3 day	3 days	3 days	3 days	up to 5 days	3 days	7 to 10 days

4. Safety Requirements

The agent is a low-hazardous substance that belongs to the hazard category 4 as to the exposure on the human body in accordance with GOST 12.1.007.

The product application safety rules are stated in the Material Safety Data Sheet (MSDS).

5. Application Technology

The DAD agent is added to bitumen at an asphalt concrete plant directly prior to the asphalt concrete mix preparation.

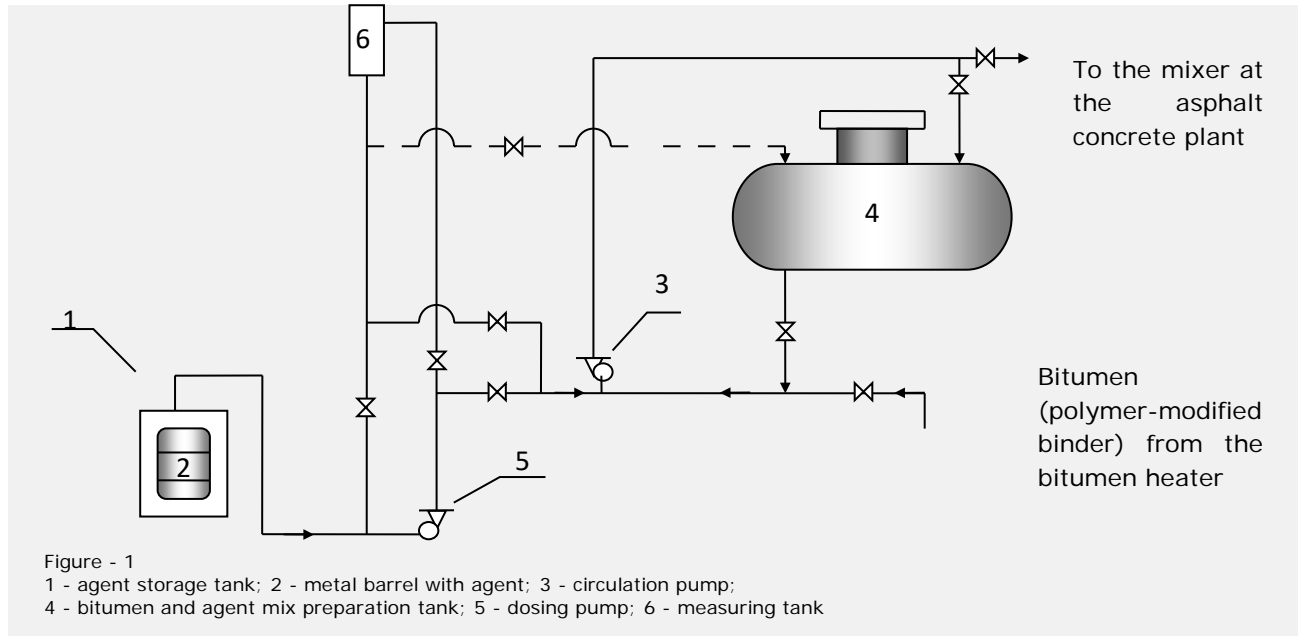
An optimal amount of the agent shall be determined for each new batch of bitumen and a batch of aggregate (or for a specific asphalt concrete mix composition), taking into account the nature and properties of the initial materials used.

The DAD adhesion agent shall be uniformly distributed in the binder to achieve the required adhesive properties.

Manual adding of the agent to the bitumen supply tank, followed by mixing with a blade agitator or using a circulation circuit, as well as automatic adding to the bitumen feed line using dedicated dosing equipment (mainly for bulk agents) are allowed.

a) Adding of the adhesion agent into the bitumen supply tank

The process flow diagram of the DAD agent adding to binders using the circulation circuit is shown on Figure 1.



1. Bitumen after evaporation from the operating heater or the prepared polymer-modified binder are pumped by the pump (3) into the tank (4) to prepare the binder and agent mix.
2. After filling the tank (4) (the tank fill factor not exceeding 0.7) with the pump (3), the binder circulation is performed. The binder temperature in the tank shall not exceed 160 °C.
3. The DAD agent is dosed into the tank (4) from the barrel (2) (installed in the barrel heating chamber) with the pump (5) through the measuring tank (6) or directly into the bitumen tank (4). The agent can be also added manually into the bitumen supply tank through the upper filling hatch especially convenient to be used for bulk agents.
4. The circulation pump (3) mixes the adhesion agent with bitumen. The circulation duration shall provide for at least twofold product exchange in the tank (4).

The example of the circulation duration calculation is as follows:

Initial data for the calculation:

bitumen tank (4) volume, V_1 ,	-----	16.0 m ³
binder volume in the tank, V_2 ,	-----	11.2 m ³
pump flow rate (3), Q_3 ,	-----	50.0 m ³ /h

Based on the above data, the circulation duration t is:

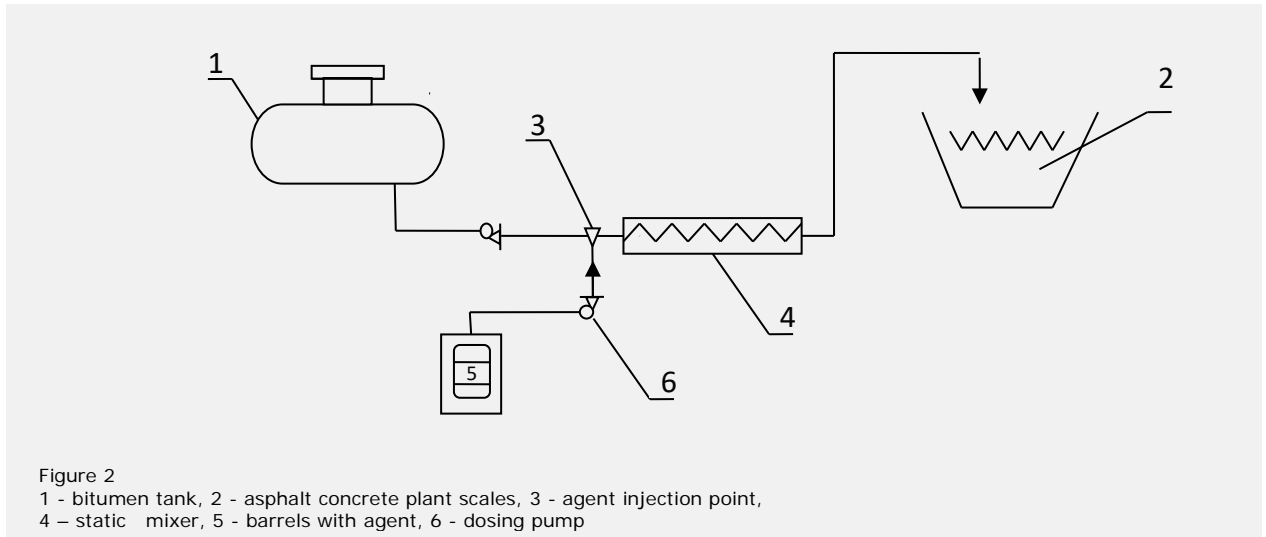
$$t = V_2 \times 2 / Q_3 = 11.2 \times 2 / 50 = 0.45 \text{ h (27 min)}$$

The agent is most effectively mixed with bitumen, if the supply tank is equipped with an agitator. The time of the agent uniform distribution in bitumen decreases upon simultaneous bitumen circulation and mixing with the blade agitator.

b) Adding of the adhesion agent to bitumen directly prior to the bitumen supply into the mixer of the asphalt concrete plant.

All adhesion agents are subject to destruction to a variable degree under the influence of high temperatures (160-180 °C). Therefore, when using agents, their long-term overheating (>160°C) in

bitumen is not recommended. Such overheating results in aging of the binder itself as well. The best method of adding the agent to bitumen is dosing of the same into the bitumen pipeline upstream of the weighing bitumen batcher (upstream of the mixer) (ref. to Fig. 2).



This method involves minor plant upgrades. However, such costs will be compensated through improving the asphalt concrete quality.

In the bitumen pipeline section, the static mixer (4) designed to effectively mix the liquid flowing through it is tied in between the bitumen tank (1) and the asphalt concrete plant scales (2), downstream of the agent injection point (3).

The adhesion agent is added to bitumen in a given proportion using the dosing pump (6).

The bitumen and agent mix enters the static mixer (4), where it is thoroughly mixed.

The main advantage of this method is the extremely high uniformity of the agent distribution in the volume of bitumen.

6. Laboratory Inspection

Laboratory inspection shall be carried out at all process stages starting from the preparation of bitumen containing the DAD agent, and up to the asphalt concrete mix preparation, laying and compacting on the road.

When arranging asphalt concrete pavings using the agent, it is required to control the quality of bitumen, adhesion agent, bitumen with the agent, aggregates and the accuracy of their dosage, as well as the correct assignment of the agent concentration, the quality of asphalt concrete mixes and compliance with the process parameters and standards of their preparation.

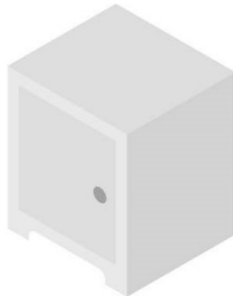
DAD agent is accepted according to the Quality Certificate issued by the QC Department. The quality of DAD shall comply with the requirements of STO 22320188-001-2014 industry standard.

The quality of the original viscous bitumen shall be verified in accordance with GOST 22245-90, the quality of liquid bitumen - in accordance with GOST 11955-82, the quality of bitumen with adhesion agents - as per the procedure described below (in accordance with GOST 12801-98 with amendments).

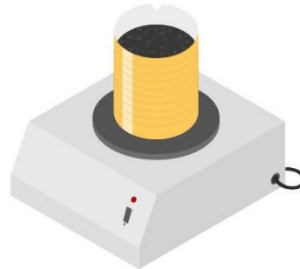
The quality of original aggregates of the ready-mix asphalt concrete is determined in accordance with GOST 9128-2013, the quality of stone matrix asphalt (SMA) - in accordance with GOST 31015-2002.

Procedure to Determine the Adhesion of the Binder to the Aggregate Surface (in accordance with GOST 12801-98 with amendments No.1)

The adhesion quality is visually assessed as per the degree of the binder film preservation on crushed stone grains following its boiling in distilled water.



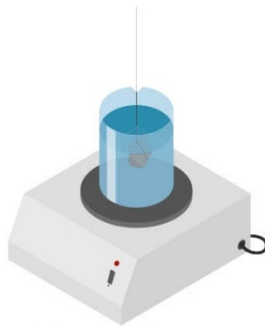
Dry stones in a drying box,
160–165°C, 60 min



Put into bitumen with
the additive, 165°C, 15sec



Dry with room
temperature, 60 min



Put into boiling
water, 30 min



Cool in cold distilled water,
1–3 min



Dry 30–60 min and
visually evaluate

Controls and Auxiliaries

- Heat-resistant beakers in accordance with GOST 23932 with a capacity of minimum 500 cm³.
- Hot plate, sand bath or gas burner.
- Distilled water in accordance with GOST 6709.
- Filter paper

Test Preparation Procedure (exemplified by Pavlovsk granite)

1. Aggregate Preparation.

Selection of 15-20 mm fraction granite from Pavlovsk open-pit mine. Tie each sample round with a thread or a thin wire (maximum 0.5 mm in diameter), wash in distilled water, dry for 1 hour at 160°C – 165°C in a drying cabinet.

2. Bitumen Preparation.

Heat the original bitumen to 165°C and dehydrate it. Add the calculated amount of the tested adhesion agent (AA) to the bitumen sample, mix for uniform distribution of the agent in the binder (minimum 15 minutes).

Test Procedure

1. Immerse the pre-heated aggregate in bitumen with the agent for 15 seconds, then hold it for 1 hour at room temperature.

2. Dip the samples of granite covered with bitumen in boiling water for 30 minutes. Water boiling shall not be vigorous. Remove the emerged bitumen from the water surface in the process of boiling with filter paper.

3. Take the granite and bitumen samples out of boiling water and place them in a beaker with cold distilled water for 1-3 minutes. Then, hold the samples at room temperature for 30-60 minutes until the water drops on the surface completely dry out.

4. Visually determine the binder film preservation after boiling on the aggregate grains, assign the points according to the table.

Characteristics of the bitumen film on the crushed stone surface	Adhesion quality assessment
The binder film has been completely preserved on the surface, while its thickness may be somewhere reduced.	Excellent (five points)
The binder film has been completely preserved on the surface, but has partially separated from sharp corners and ribs.	Good (four points)
More than 50% of binder film have been preserved on the crushed stone surface.	Satisfactory (three points)
Less than 50% of binder film have been preserved on the crushed stone surface. Individual bitumen drops are observed on the exposed surface.	Bad (2 points)

Processing Test Results

The test results are taken as the maximum number of points, but not lower than three points, received as a result of testing six crushed stone grains, if the bitumen binder film characteristics are the same for all grains. If the bitumen film characteristics do not match on different grains, the double number of crushed stone grains is tested, and the test result is determined by the largest number of crushed stone grains demonstrating the same characteristics (in accordance with GOST 12801-98).

The final test table is prepared, and the conclusions are made on the efficiency of the tested AA batch in comparison with pure bitumen.

Such test is carried out involving pure bitumen and bitumen with the addition of DAD adhesion agent. Finally, the results are compared, and the optimal agent dosage in relation to the used materials and conditions is determined.

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