ENGINEERING BULLETIN

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Supersedes: New

PRODUCT: VAV Water Coils
SUBJECT: Performance Advantages of Opposed Blade VAV Terminal Units with Hot Water Coils

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A recent ASHRAE Journal publication, "Rethinking VAV Hot Water Terminal Unit Design," evaluated the thermal and airflow implications of single-blade, 90-degree rotation dampers (round butterfly dampers) in VAV terminal units. The article (12-2024) highlighted adverse effects on hot water coil performance and inaccuracies in Discharge Air Temperature (DAT) sensor readings due to significantly uneven airflow. The proposed remedies included recircuiting water coils and relocating DAT sensors. However, these challenges are not universally applicable, specifically for VAV terminals that employ inclined opposed blade dampers.

To further evaluate this issue, a controlled study was conducted utilizing a VAV terminal unit equipped with a 45° closure opposed blade damper (OBD). While this design was previously adopted by multiple manufacturers, it is now exclusive to Nailor Industries. The opposed blade configuration inherently delivers a more uniform downstream airflow distribution when compared to single-blade damper designs.

A series of laboratory tests were conducted at the Energistics Research Laboratory. The test setup included a single-duct VAV terminal with a 45° OBD upstream of a standard capacity 2-row hot water coil. To assess thermal dispersion, three 25-point thermocouple grids were positioned 1.5, 2.5, and 3.5 feet downstream of the coil. Additional instrumentation included flow meters and temperature sensors on entering and leaving water lines, along with velocity measurements at 30 downstream air points. Tests were carried out under varied damper positions and inlet static pressures.

The findings, detailed in the Energistics Research Report **"Performance Evaluation of Opposed Blade Damper VAV Terminals with Hot Water Coils"**, show that the 45° OBD configuration delivers uniform airflow and thermal profiles, closely matching the water coil's rated performance as per AHRI Standard 410, in comparison to the single blade damper with 2-row HW coil performance shown on the Berkeley report referenced in the ASHRAE Journal publication (see Fig. 1). These uniformity results represented in the schematic, (see Fig. 2) show reliable heat transfer across the coil surface and consistent air temperature distribution at all blade positions (see Fig. 3). Unlike single-blade damper systems, the OBD design does not require coil recircuiting to improve performance or alternative DAT sensor locations to maintain accurate readings.

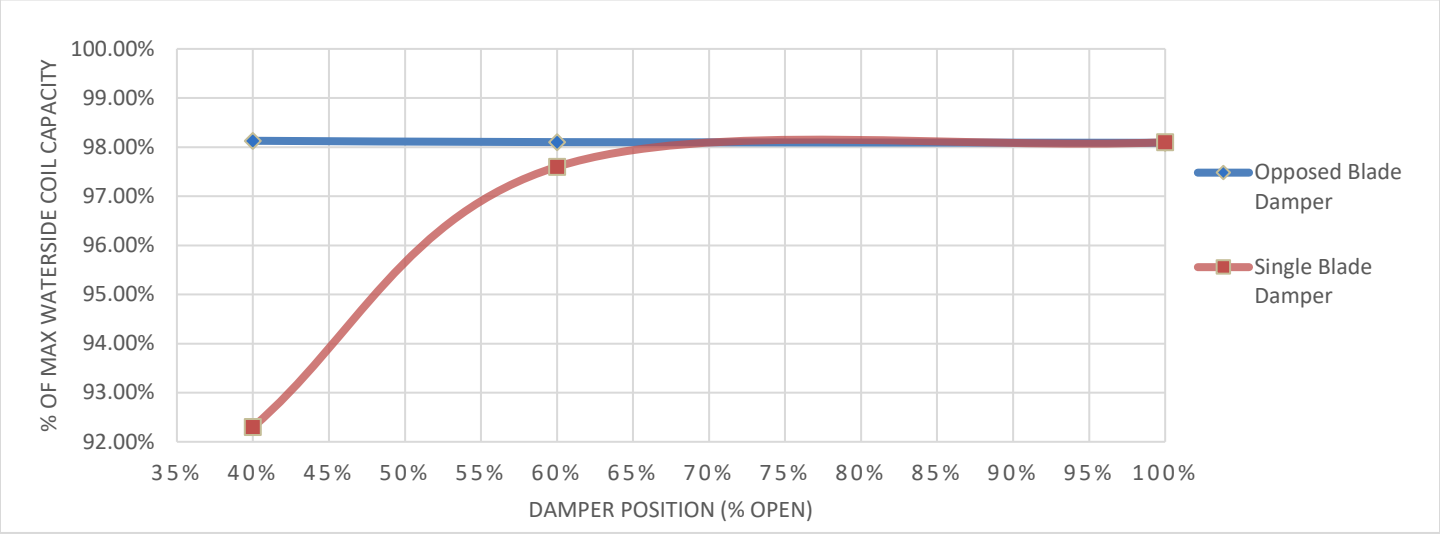

Fig. 1 Damper Position vs Coil Capacity with Constant Air Flow

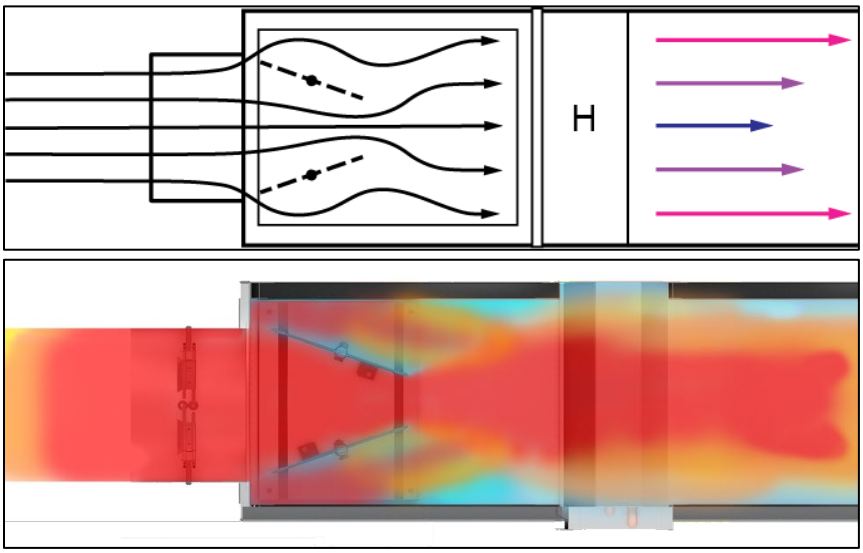

Fig. 2 Schematic and Simulation of Air Velocity Profiles with OBD

Velocity FPM 50" Downstream				
EWT 150°F EAT 60°F **40%** Open Damper				
1432	1386	1365	1196	1074
1068	1006	1001	972	921
1010	1021	1013	898	880
1033	1112	1115	960	975
1403	1178	899	1014	989

Velocity FPM 50" Downstream				
EWT 150°F EAT 60°F **60%** Open Damper				
1305	1222	1152	1172	1074
1020	1040	1021	963	950
1084	1083	956	802	885
1141	851	904	840	908
1245	944	803	1090	960

Velocity FPM 50" Downstream				
EWT 150°F EAT 60°F **100%** Open Damper				
1470	1396	1394	1328	1240
1158	1156	1245	1086	902
1022	1150	1064	875	770
992	935	874	919	813
1385	1053	960	1112	1070

Thermocouple Grid 3.5ft				
EWT 150°F EAT 60°F **40%** Open Damper				
83.04	83.6	84.05	84.29	84.18
82.47	82.69	83.17	83.5	83.79
82.78	82.89	83.75	84.07	84.74
84.36	86.36	87.53	87.93	86.29
86.43	91.3	91.56	89.89	89.15

Thermocouple Grid 3.5ft				
EWT 150°F EAT 60°F **60%** Open Damper				
82.02	82.12	82.33	82.83	83.05
82.75	81.79	81.91	82.73	83.81
84.7	82.32	81.88	84.46	85.95
87.23	84.31	83.53	84.81	86.99
87.62	87.99	87.44	87.97	90.2

Thermocouple Grid 3.5ft				
EWT 150°F EAT 60°F **100%** Open Damper				
81.6	80.75	80.71	82.13	82.85
84.09	82.97	81.49	82.68	84.53
87.59	86.51	82.69	85.37	87.98
93.02	88.03	83.21	84.62	87.49
91.13	86.27	84.3	86.36	89.44

Fig. 3 Test Data Results of Temperature and Velocity Downstream of VAV Terminal Unit

These performance advantages extend to both hydronic and electric heating applications. For electric heaters, uniform airflow ensures proper operation of embedded safety devices and allows for greater installation flexibility, including inverted mounting—without compromising system safety or efficiency, as well as permitting shorter overall length units that meet all the necessary UL and AHRI Standards.

VAV terminal units incorporating 45° opposed blade dampers maintain rated water coil capacity and thermal performance even under part-load conditions, which predominate in typical applications. The uniform discharge velocity also simplifies DAT sensor placement, which becomes less sensitive to airflow skewing—addressing a major issue with single-blade designs. Maintaining consistent airflow across the coil face area is also crucial for compliance with ASHRAE 62.1, which limits the supply air ΔT to 15°F (in addition to the 90F limitation of Standard 90.1) to prevent stratification and excessive ventilation penalties. Similarly, ASHRAE 55 discourages vertical temperature gradients exceeding 15°F to maintain occupant comfort.

In conclusion, VAV terminals with 45° OBD dampers offer demonstrable advantages over single-blade configurations. They ensure that the water coil operates at its rated performance, optimizing heat transfer efficiency even under low entering water temperature conditions, enable flexible installation (including inverted mounting when vent/drain locations are swapped), and ensure accurate DAT sensing independent of airflow variations. These results underscore the engineering benefits of using opposed blade dampers in VAV terminal applications—offering a robust, standards-compliant solution for modern HVAC design challenges.