APPLICATION OF ECO-STAR™/ECO-STARII™ BURNERS WITHOUT COMBUSTION CHAMBERS ON ROTARY AGGREGATE DRYERS

The dryer combustion zone must be sized to allow full development of the Eco-Star™/ Eco-StarII™ burner flame. The burner main air spin adjustment provides flame shaping to meet a variety of combustion zone sizes.

Combustion Volume

When applying an Eco-Star™/Eco-StarII™ to a rotary dryer, the flame must not only have the correct volume to burn, but also must be free from any material falling into or through the flame. If material vails or showers through the flame, the fire cools and results in incomplete combustion. Cooling the flame from material impingment is commonly called flame quenching. Quenching will result in several undesirable outcomes. In situations where quenching exists, fuel will not be fully burned. When fuel is not fully burned, efficiency is reduced and emissions of Total Hydrocarbon (THC) and Carbon Monoxide (CO) are significantly increased. Furthermore, on oil fired applications, material contamination can occur if material falls through the oil flame. In short, a combustion zone that has material vail can result in elevated operating costs, increased pollutant emissions and result in scrapped material. Solutions to problems of combustion zone size and material vailing will be addressed in this application sheet.

To prevent vailing, combustion zone flights are required. Bolted in flights are recommended for aggregate dryers. The recommended combustion flights are designed to be low profile for prevention of flight overheating and they provide full radiation shielding to keep the drum temperature to a minimum. Typically, the combustion zone flights are installed in two sets. In long combustion zones, however, additional sets might be needed to keep the individual flight length down to a manageable length (6 feet or less). Hauck does not recommend carrying material. The dam installed in front of each set of combustion zone flights have a 4 inch opening between the dam sections. These openings allow a portion of material to go under the flights to help cool the drum.

On most drums using the recommended combustion flighting, the hottest section of the drum is at the first set of material drying vailing flights. Due to the vailing flights being higher than the combustion flights, little radiation protection exists for that section of the dryer. Temperatures in this area can vary depending on drum diameters and amount of burner spin used. Typically the temperature in this section will be around 500°F and has been successful installed on parallel flow and counter-flow applications. If the application has an overheating problem, a dam or radiation plate can be installed in this area to help reduce temperatures. Drum temperatures in the combustion zone are usually less 500°F to 750°F. Considering that the Eco-Star™/Eco-StarII™ efficiently operates with a slight amount of excess air and produces a 3000°F flame, the recommended combustion flighting works well.

Combustion Zone Sizing

The following example demonstrates how to calculate the necessary combustion zone length. (Hauck's e-Solutions Asphalt Heat Balance program is also available.)

1. Determine the maximum Btu/hr from the burner capacity sheet necessary; assume burner capacity of 100,000,000 Btu/hr for this example.

2. Take the Btu/hr and divide it by the combustion zone intensity that is desired. (In a normal case, use 250,000 Btu/ft^3. hr.)

   100,000,000 Btu/hr ÷ 250,000 Btu/Ft^3.hr = 400ft^3 of combustion space required.

3. Determine the effective combustion zone inside diameter(ID). Use the drum diameter in inches minus two times the height of the combustion flights.

   If the drum is 96" in diameter and the flight height is 6", the effective drum inside diameter is:

   96" - (2 x 6") = 84" effective combustion zone ID.

4. Use the effective combustion zone ID to calculate the amount of cubic feet per foot of drum length.

   (Effective Combustion Zone ID÷2)^2 x 0.02181

   In The Example:
   (84"÷2)^2 X 0.02181 = 38.5ft^3 combustion volume / ft drum length.

5. To determine the drum length required in feet, divide the combustion volume required (see step 2) by the cubic feet per foot of drum (Step 4).

   400ft^3 ÷ 38.5ft^3 / ft drum length = 10.4ft combustion flighting required.

For most applications this method produces good results, however for unusual configurations or firing rates the flame lengths for the burners should be checked to ensure that the planned combustion length and diameter is within the burner's capability. (see attached flame length tables).

Combustion Zone Produces Flame Intensity

The Eco-Star™/Eco-StarII™ is capable of high flame intensities. Flame intensity is defined as Btu/hr.Ft^3 of combustion space. This is determined by finding the Btu/hr firing rate that is used and dividing it by the cubic feet of combustion space available. A normal maximum flame zone intensity is 250,000 to 300,000 Btu/ft^3 on natural gas and 175,000 to 250,000 Btu/Ft^3 on oil firing. Propane fired burners require 150,000 to 200,000 Btu/ft^3. This intensity can be higher under ideal conditions, or lower if pollution requirements necessitate very low CO and THC levels. **Ideal conditions mean that the burner chosen will run near its maximum firing capability. Running the burner near its maximum capacity will allow for higher efficiency, promote optimum mixing and result in lowest emissions.** Due to the variety of rotary drying applications, the proper number to use for sizing the combustion zone is based somewhat on experience. It is a good idea to consider normal available flame shapes for the size burner that is desired as well.

When sizing a burner and combustion zone for stringent emission regulation applications, allow extra space for the flame to fully combust. Applications that require low CO and THC benefit from larger combustion zones. In situations where (flue gas recirculation) is added to reduce NOx, a larger combustion zone is also helpful. Combustion intensities in these cases will be lower. Do not be concerned when removing several more feet of vailing flighting to complete the combustion flighting as the new combustion flights will allow extra material heating and drying from conductive heat transfer. Vailing flights can be added to make up the difference in the balance of the drum (Consult Hauck).

For example, consider an ESII-100 firing natural gas at 100 million Btu/hr in an 8ft. diameter drum. First, use 250,000 Btu/ft^3 as the combustion intensity and then check to see if the flame fits into the available combustion zone. This is a 9ft. long x 5ft. diameter flame @ 30° spin in an 8ft. diameter dryer which appears reasonable. Consideration must be made for combustion flights. For instance, an 8ft. drum becomes 7ft. if the combustion flights are 6 inches high. Thus the required combustion length using 7ft. diameter = 10.4ft. long (see combustion zone sizing example). This arrangement will probably produce 300 to 600 ppm of CO @ 7% 0_2. In a 10ft. diameter drum, the calculated combustion zone would be too short at only 6.3ft. long. A length of 6.3ft. is shorter than the recorded flame length at full spin of 8ft. long for natural gas (See Flame Dimension sheets for the Eco-Star™/Eco-StarII™). If on the same example the CO requirement was below 500 ppm, then the combustion zone should be more generous to ensure that all the flame is contained in the non-vailing zone. The maximum flame length must be checked against the calculated combustion zone length.

Burner mounting is determined by the type of plant and the fuel used. The Eco-Star™/ Eco-StarII™ comes standard with a nose that can be inserted into most drums to prevent overheating of the breech plate. Insertion depth depends on the fuel and the configuration of the inside of the dryer. If there are any inside projections, such as an overhead discharge, make sure the burner is inserted far enough to be even with or slightly past the overhead discharge. On oil, the burner may need to be inserted 6 to 12 inches past the internal discharge chute, or on gas, it is possible to insert the burner even with the chute. For dryers without internal projections, the Eco-Star™/Eco-StarII™ only needs to be installed 12 to 18 inches past the breech plate on gas or propane firing. Oil fired burners should be inserted 18 to 24 inches from the breech plate. These distances, on most plants, produce acceptable breech plate temperatures in the 300-550°F range except on extremely well sealed plants, or when the high swirl (Shortest) flame is required. Breech overheating can be usually remedied by sliding the burner further into the drum or by installing stainless steel radiation shielding plates on the inside of the breech plate if the burner cannot be moved into the drum. Make provisions to slide the burner into the dryer when installing the burner on the drum.

Please Note The Following Important Considerations:

1. Flight spacing of 1/4 inch between flights is important in keeping the combustion zone drum shell temperatures to a minimum. The drum shell should not be exposed directly to the flame. If the drum is exposed, as in the case of uneven flight spacing or missing flights the drum shell temperature in that area could run over 600°F.

2. Dams must be used on the upstream side of the flight. The dams on the upstream end of the flights allow a small amount of material to go under the flight thru the dam openings provided. Each set of flights will have a dam upstream of it.

Flame Sizes For Eco-Star™/Eco-StarII™ Burners In Feet

Size	Spin Setting	Oil High Pressure (Compressed Air)		Oil Low Pressure (TBA)		Gas		Liquid Propane		Max.Firing Rate MMBTU/HR
		Length	Diameter	Length	Diameter	Length	Diameter	Length	Diameter	@ 25% XSA
ES 25	0	NA	NA	14	2.75	13	2.5	12	3	35
	45°	NA	NA	8	3.5	8	4	8	3	34
	60°	NA	NA	8	4	7.5	4.5	8	3.5	33
ES 50	0	NA	NA	14	3	15	3	12	3	62
	45°	NA	NA	10	4	12	4	9	3.75	63
	60°	NA	NA	7	5.5	7	6	7	6	60
ESII 75	0	11	4	14.5	5	15	5	13	4.5	75
	30°	8	7	13	5	13.5	6.5	14	5	75
	45°	6	7	10	7.5	8.5	8	12	7	75
	60°	4.5	8	8	9	7	8	8	8	75
ESII 100	0	15	4	18	5.5	15	5	19.5	5	100
	30°	11	5.5	12	7	9	5	17	5	100
	45°	8	7	7	9	9	8	7	10	100
	60°	5	9	6	10	8	10	6	13	100
ESII 125	0	12	4	9	4.5	15	6	15	5	125
	30°	10	5	8	4.75	11	8	12.5	6	125
	45°	6	6.5	6	8	8	8	10	6	125
	60°	6	8.5	6.5	8.5	8	9.5	9	6	125
ESII 150	0	9	6	11	7	16	6	15.5	6.5	150
	30°	8	7	9.5	7	11	6	14.5	6.5	150
	45°	5	9	5	10	10	7.5	9.5	8	150
	60°	4.5	9	4	10	8	9	8.5	10	150
ESII 175	0	16	6.5	15	6.5	19	7	13	6	175
	30°	10	6.5	11	7	15	8	14	5	175
	45°	9	7	10	7.5	14	9.5	13	7.5	175
	60°	9	10.5	8.5	9.5	13	9.5	11.5	8	175
ESII 200	0	18	6.5	17	6	20	7	15	5	200
	30°	12	7	14	8	14	9	14	6	200
	45°	10	8	10	8.5	14	10	14	7.5	200
	60°	10	10	9	10	14	10	12.5	8	200

Capacity Correction Table

Eco-Star™/Eco-Starll™ Burners At Altitude

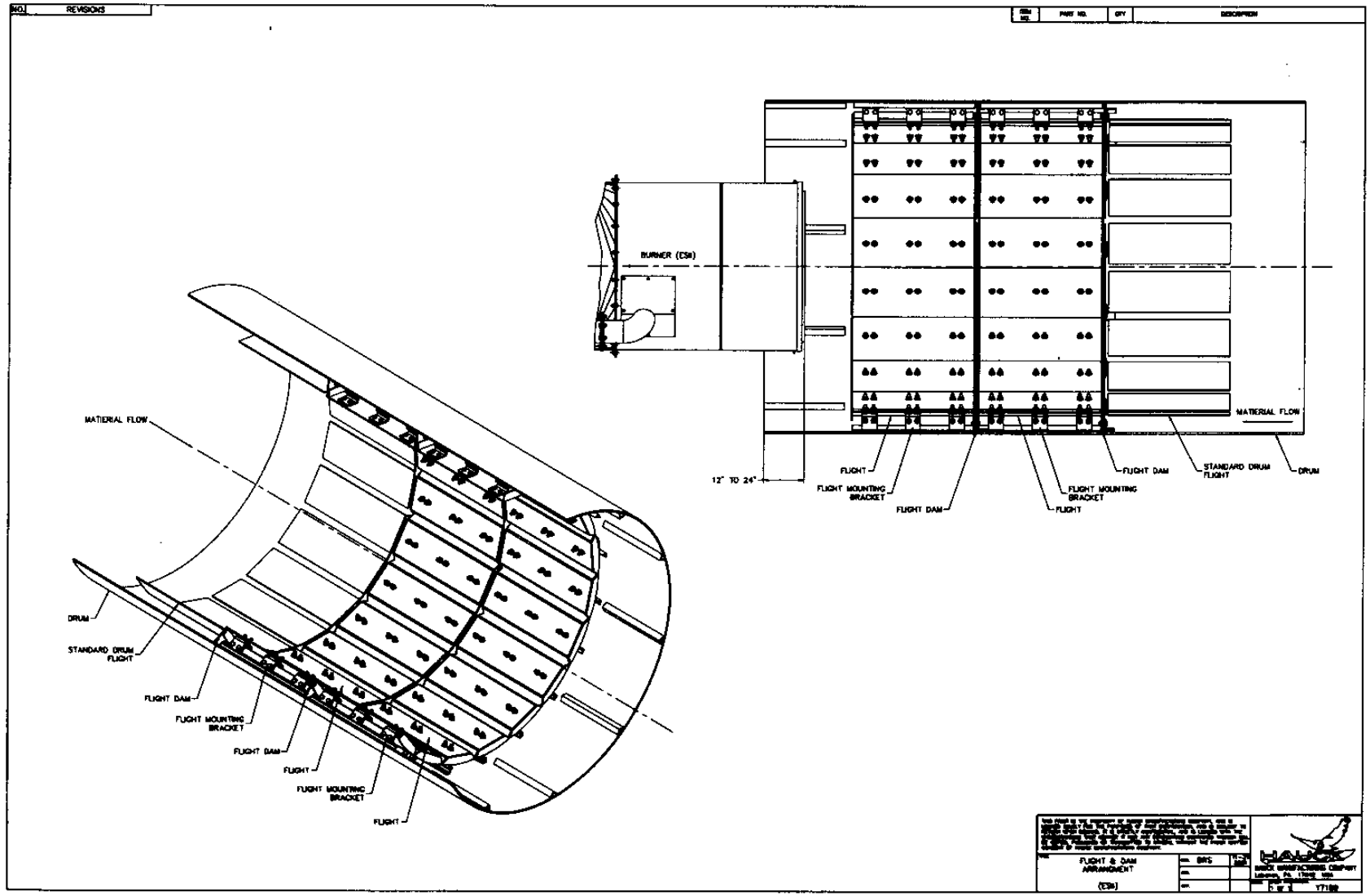
Altitude Above Sea Level (Ft.)	Air Density	Blower Pressure Factor	Atomizing Blower Pressure osi At altitude	Blower Pressure (osi) Required At Sea Level*	Capacity @ 60HZ (10^6Btu/hr.)							
					ES 25	ES 50	ESII 75	ESII 100	ESII 125	ESII 150	ESII 175	ESII 200
0	1	1	36.0	32	34	63	77	102	128	153	179	204
500	.98	.97	35.4	33	33	62	75	100	125	150	175	200
1000	.97	.94	34.9	34	33	61	74	99	124	148	173	198
1500	.96	.91	34.4	35	33	60	73	98	122	147	171	196
2000	.94	.9	33.9	35	32	59	72	96	120	144	168	192
2500	.93	.86	33.4	37	32	58	71	95	119	142	166	190
3000	.91	.84	32.9	38	31	58	70	93	116	139	163	186
3500	.90	.81	32.4	39	31	57	69	92	115	138	161	184
4000	.89	.79	32.0	40	30	56	68	91	114	136	159	182
4500	.87	.76	31.5	42	30	55	67	89	111	133	155	178
5000	.86	.74	31.0	43	29	54	66	88	110	132	154	176
5500	.85	.72	30.5	44	29	53	65	87	108	130	152	173
6000	.84	.70	30.1	46	28	53	64	86	107	129	150	171
6500	.82	.68	29.6	47	28	52	63	84	105	126	148	167
7000	.81	.66	29.2	48	28	51	62	83	103	124	145	165
7500	.80	.64	28.7	50	27	50	61	82	102	122	143	163
8000	.79	.62	28.3	52	27	50	60	81	101	121	141	161
8500	.77	.60	27.8	53	26	49	59	79	98	118	138	157
9000	.76	.58	27.4	55	26	48	58	78	97	116	136	155
9500	.75	.56	27	57	25	47	57	77	96	115	134	153
10000	.74	.54	26.6	59	25	46	57	76	94	113	132	151
10500	.73	.53	26.2	60	25	46	56	74	93	112	130	149
11000	.72	.51	25.7	63	24	45	55	73	92	110	129	147
11500	.70	.50	25.3	64	24	44	54	71	89	107	125	143
12000	.69	.48	24.9	67	24	44	53	70	88	106	123	141
12500	.68	.46	24.5	70	23	43	52	69	87	104	121	139
13000	.67	.45	24.1	71	23	42	51	68	85	103	120	137
13500	.66	.44	23.8	73	22	42	51	67	84	101	118	135
14000	.65	.42	23.4	76	22	41	50	66	83	99	116	133
14500	.64	.41	23.0	78	22	40	49	65	82	98	114	131
15000	.63	.40	22.6	80	21	40	48	64	80	96	113	129

Limit for 36 oz. Blower. Above this altitude use the blower altitude kit or compressed air atomization.

4500 Ft. For Light Oil

2500 Ft. For Heavy Oil

For ES25 and ES50, the blower altitude kit is the only available option for high altitude installations.


NO.
REVISIONS
ITEM NO.
PART NO.
QTY
DESCRIPTION
BURNER (ESI)
MATERIAL FLOW
12" TO 24"
FLIGHT
FLIGHT MOUNTING BRACKET
FLIGHT DAM
FLIGHT
FLIGHT DAM
STANDARD DRUM FLIGHT
DRUM
MATERIAL FLOW
DRUM
STANDARD DRUM FLIGHT
FLIGHT DAM
FLIGHT MOUNTING BRACKET
FLIGHT DAM
FLIGHT
FLIGHT MOUNTING BRACKET
FLIGHT
FLIGHT & DAM ARRANGEMENT
(ESI)
BMS
HAUCK
Y7189