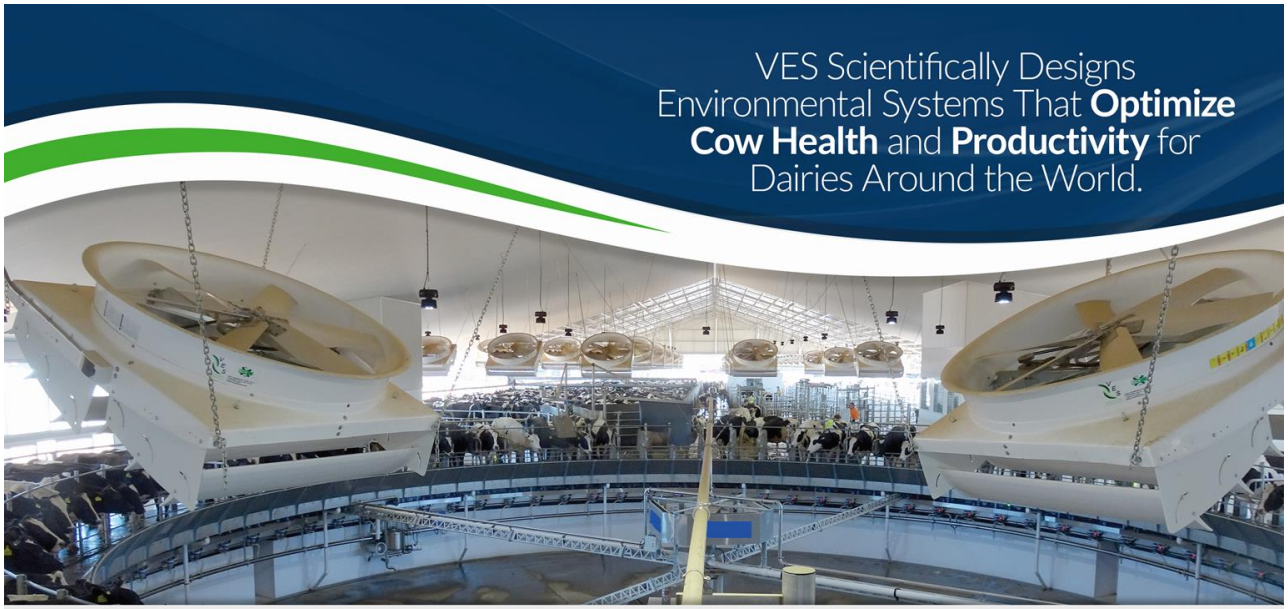


1

Goals of Effective Cooling System

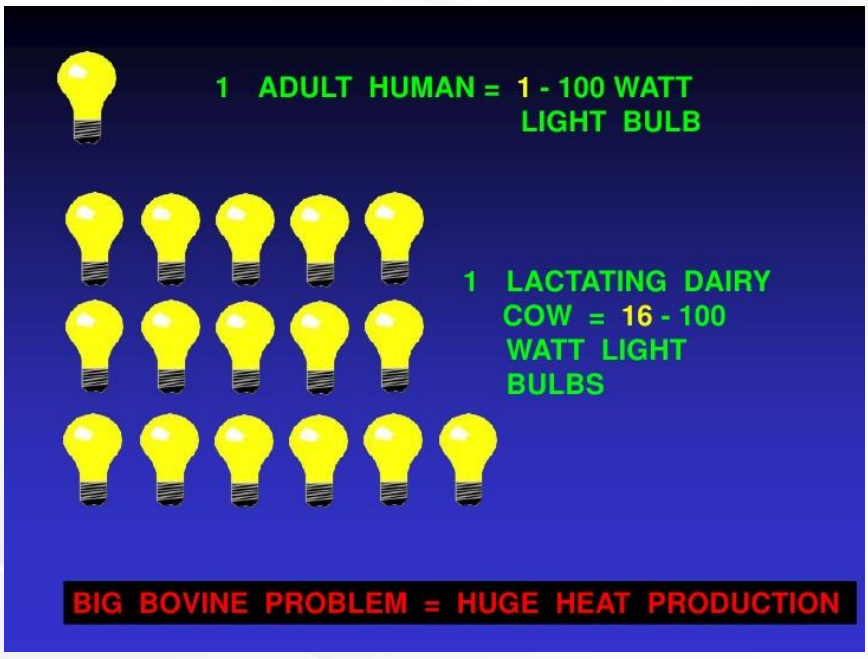
- **Fresh Air Introduced at a Rate Appropriate for Climate Conditions**
- **Directed to the Cow's Living Space Especially Freestall Bed & Holding Pen**
- **Minimize the Increase of Core Body Temp (CBT) in Intensity & Duration**
- **Return the Cow to Her Basal CBT Before the Next 24 Hr Interval**

3

Goals of Effective Cooling System

- **Should Not Increase Thermal Heat Index (THI)**
- **Reduce Potential Disease Risk**
- **Cost Effective for the Local Climate**
- **Enhance Employee Working Environment**
- **Parlor/Holding Pen System Highly Capital Effective Since Every Lactating Cow Experiences the Benefits 2-3X/Day**

4

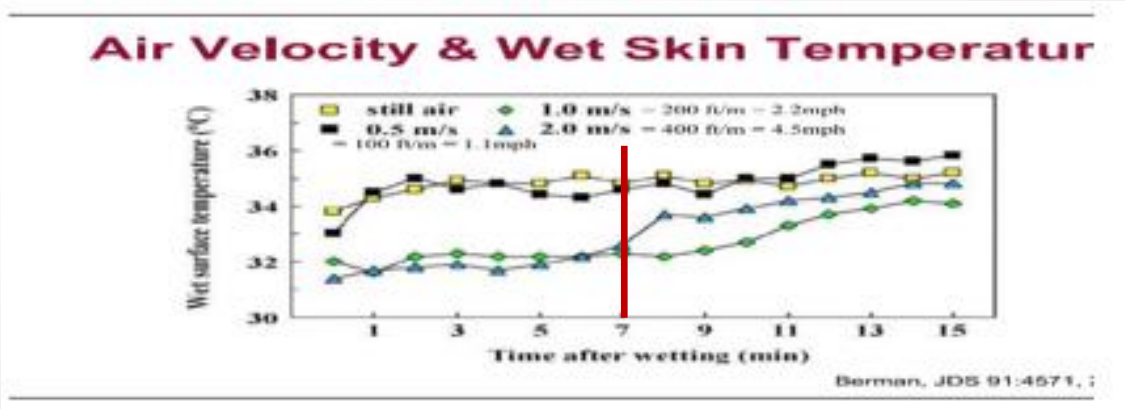


5

Table 1. Heat production by a 1,500-pound cow producing either 120 or 40 pounds of milk per day, at 4% fat and 3% protein.

Heat Production	120 lbs./day	40 lbs./day
BTU/ cow per day	152,000	79,000
BTU/ cow per hour	6,300	3,300
BTU/ per hour, per square foot of floor in the barn	79	41
BTU/ per hour, per square foot of floor in the holding pen	525	275
BTU/ per hour, per square foot of effective cow skin in the barn	105	55
BTU/ per hour, per square foot of effective cow skin in the holding pen	630	330

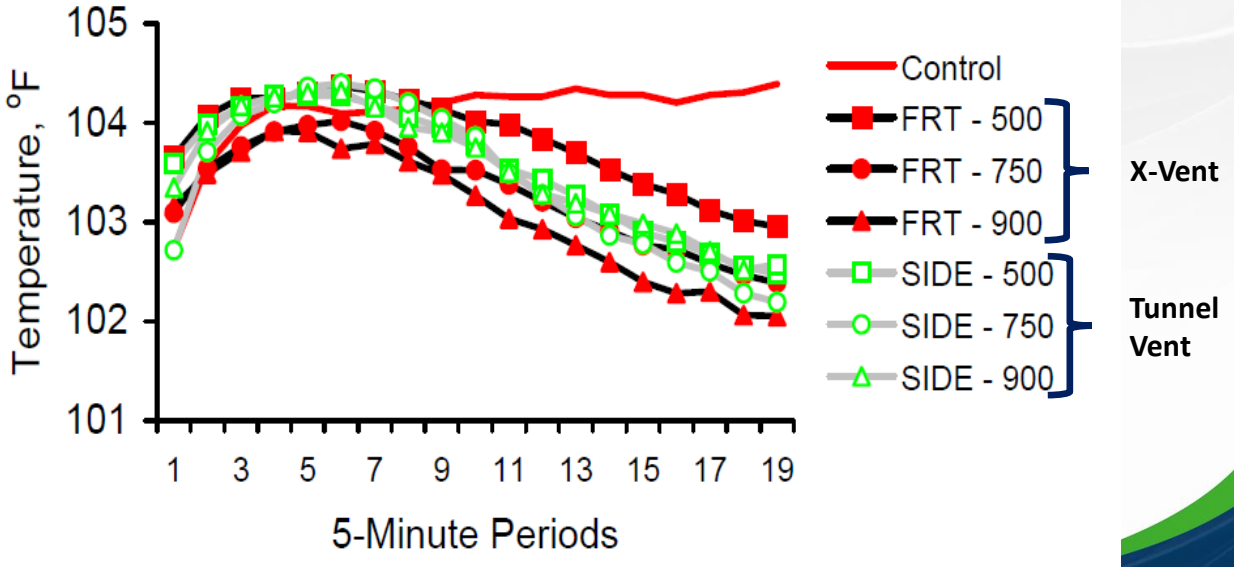
6



7

RESPONSES OF LACTATING HOLSTEIN COWS TO DIFFERING LEVELS AND DIRECTION OF SUPPLEMENTAL AIRFLOW

M. J. Brouk, J. P. Harner[1], J. F. Smith, W. F. Miller, and B. Cvetkovic



8

Respiratory Rate Highly Correlated to CBT

- Stress Threshold Respiration rate exceeds 60 BPM. Milk yield losses begin. Repro losses detectable. Rectal Temperature exceeds 38.5°C (101.3°F)
- Mild-Moderate Stress Respiration Rate Exceeds 75 BPM. Rectal Temperature exceeds 39°C (102.2°F)
- Moderate-Severe Stress Respiration Rate Exceeds 85 BPM Rectal Temperature exceeds 40 °C (104°F)
  Death Rates Rise
- Severe Stress. Respiration Rate 120-140 BPM. Rectal Temperature exceeds 41 °C (106°F)

9

Rear Udder Skin Temperature

- Rear udder skin temps in excess of 94°F (34°C) are considered to be in heat stress
- Easily done in parlor or as you walk the freestall barn

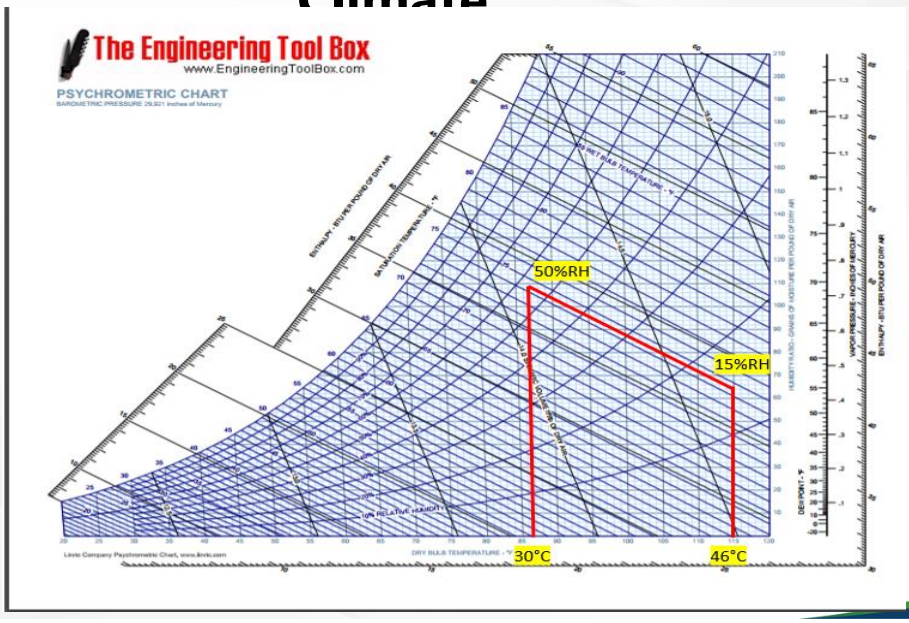
10

HPF Systems

- Professional HPF Design Engineer Required for Effective Performance
- HPF Must Include an Air Exchange Strategy
- Design & Implementation Parameters of HPF Must Account for Ambient Temperature & Humidity
- Humidity Sources Accounted for: (respiratory, fecal, urine, feed & soaker systems)
- %RH Feedback Essential for Controlling Lower & Upper Limit Set Points for each stage
- HPF Control is Integrated into the Overall Ventilation Control System

11

HPF Cooling Potential Arid Climate



12

HPF Cooling Potential & THI Impact

Themperature		% Relative Humidity																		
°F	°C	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
72	22.0	64	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71
73	23.0	65	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	72	72
74	23.5	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
75	24.0	66	66	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74
76	24.5	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
77	25.0	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75	76
78	25.5	67	68	68	69	69	70	70	71	71	72	73	73	74	74	75	75	76	76	77
79	26.0	67	68	69	69	70	70	71	71	72	73	73	74	74	75	76	76	77	77	78
80	26.5	68	69	69	70	70	71	72	72	73	73	74	75	75	76	76	77	78	78	79
81	27.0	68	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	79	80
82	28.0	69	69	70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81
83	28.5	69	70	71	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82
84	29.0	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83
85	29.5	70	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84
86	30.0	71	72	72	73	74	74	75	76	77	77	78	79	80	81	81	82	83	84	84
87	30.5	71	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85
88	31.0	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
89	31.5	72	73	74	75	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87
90	32.0	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88
91	33.0	73	74	75	76	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89
92	33.5	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90
93	34.0	74	75	76	77	78	79	80	80	81	82	83	85	85	86	87	88	89	90	91
94	34.5	74	75	76	77	78	79	80	81	82	83	84	86	86	87	88	89	90	91	92
95	35.0	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
96	35.5	75	76	77	78	79	80	81	82	83	85	86	87	88	89	90	91	92	93	94
97	36.0	76	77	78	79	80	81	82	83	84	85	86	87	88	89	91	92	93	94	95
98	36.5	76	77	78	80	80	82	83	83	85	86	87	88	89	90	91	92	93	94	95
99	37.0	76	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	95	96
100	38.0	77	78	79	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98
101	38.5	77	79	80	81	82	83	84	86	87	88	89	90	92	93	94	95	96	98	99
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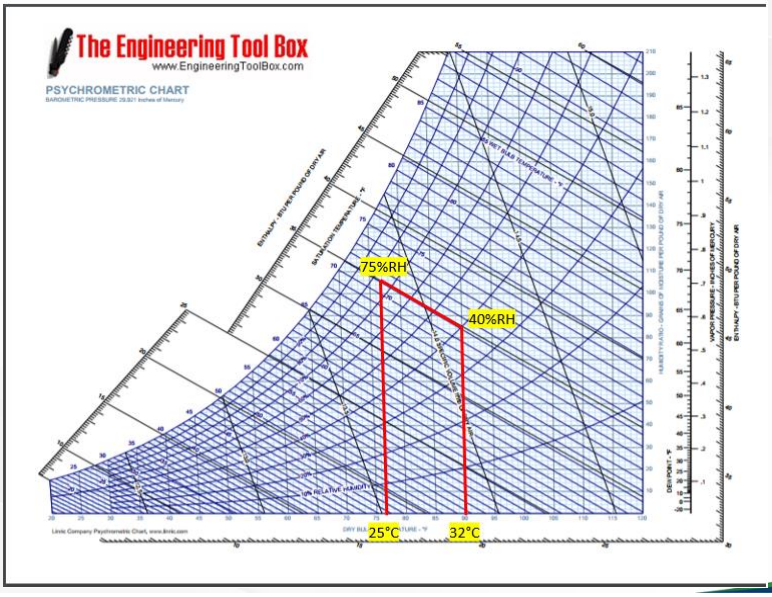
104	40.0	79	80	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101
105	40.5	79	80	82	83	84	86	87	88	89	91	92	93	95	96	97	99	100	101	102
106	41.0	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
107	41.5	80	81	83	84	85	87	88	89	91	92	94	95	96	98	99	100	102	103	104

115°F 46°C → 88

13

HPF Cooling Potential Temperate Climate



14

HPF Cooling Potential & THI Impact

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74	23.5	65	66	66	67	67	67	68	68	69	69	70	70	70	71	71	72	72	73	73
75	24.0	66	66	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74
76	24.5	66	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75
77	25.0	67	67	68	68	69	69	70	70	71	71	72	73	73	74	74	75	75	75	76
78	25.5	67	68	68	69	69	70	70	71	71	72	73	73	74	74	75	76	76	76	77
79	26.0	67	68	69	69	70	70	71	71	72	73	74	74	74	75	76	76	77	77	78
80	26.5	68	69	69	70	70	71	72	72	73	73	74	75	75	76	76	77	78	78	79
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85	29.5	70	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84
86	30.0	70	71	72	73	73	74	75	76	77	78	79	79	80	81	81	82	83	84	84
87	30.5	71	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85
88	31.0	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	86	86
89	31.5	72	73	74	75	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87
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92	33.5	73	74	75	76	77	78	79	80	81	82	83	84	85	85	86	87	88	89	90
93	34.0	74	75	76	77	78	79	80	80	81	82	83	85	85	86	87	88	89	90	91
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106	41.0	80	81	82	84	85	87	88	89	90	91	93	94	95	97	98	99	101	102	103
107	41.5	80	81	83	84	85	87	88	89	91	92	94	95	96	98	99	100	102	103	104

115°F 43°C

88

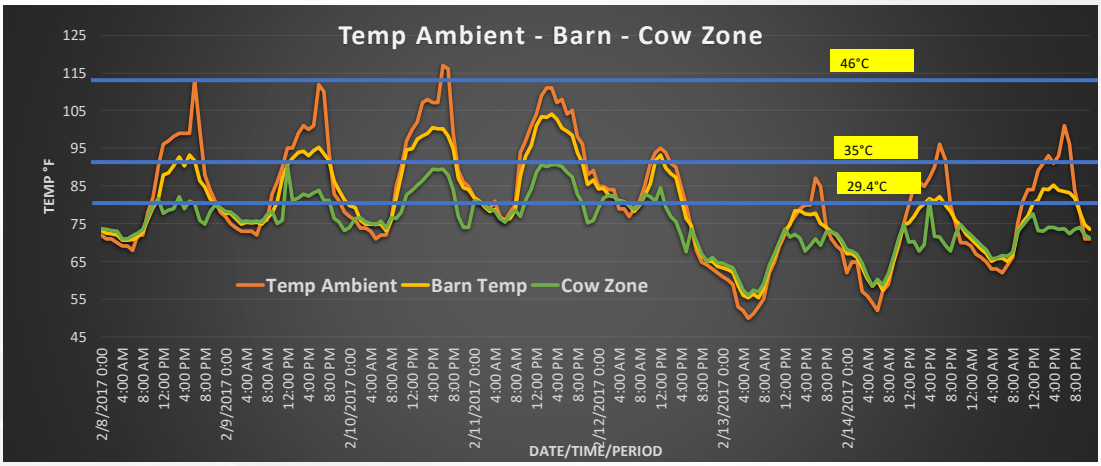
74

79

15

16

Hot Arid Climate HPF Application



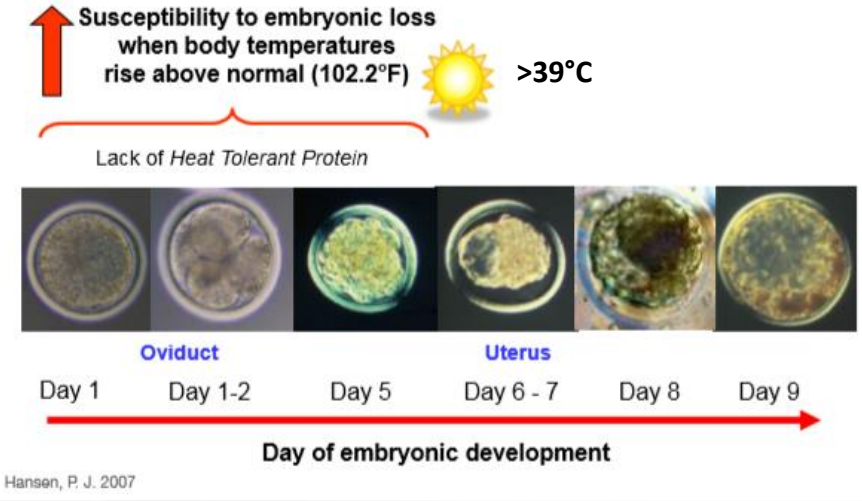
17

Parlor Deck Soaking

- Can be done in parallel & rotary systems
- Located just after unit attachment & again just before exit off the deck
- Does not effect milk letdown
- In parallel parlors the soaking is initiated when yokes are down & entry gate is closed
- It must be assured the run-off does not contact the udder & teats

28

Could Your Holding Pen be Your Bottleneck to Higher PRs?



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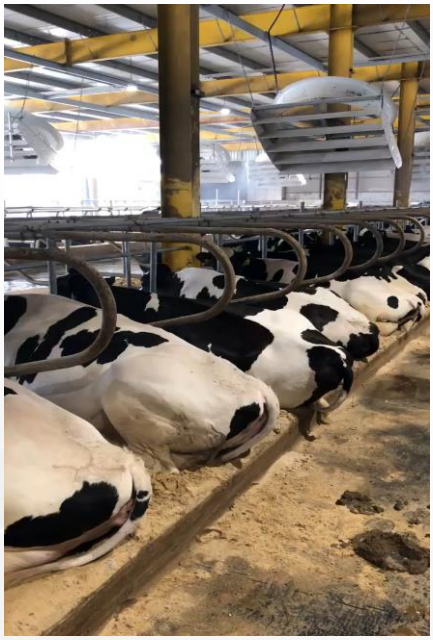

- 12 Row Crossvent with Baffles &HPF Converted to Neutral Pressure Tunnel
- High Temp Arid Climate 75% of the Year
- 50% of Exhaust Fans Repurposed to Positive Pressure Fans
- HPF combined with ECV72
- High Temp High Humidity Climate 25% of the Year
- Soaker with ECV72 Fans during high humidity climate periods

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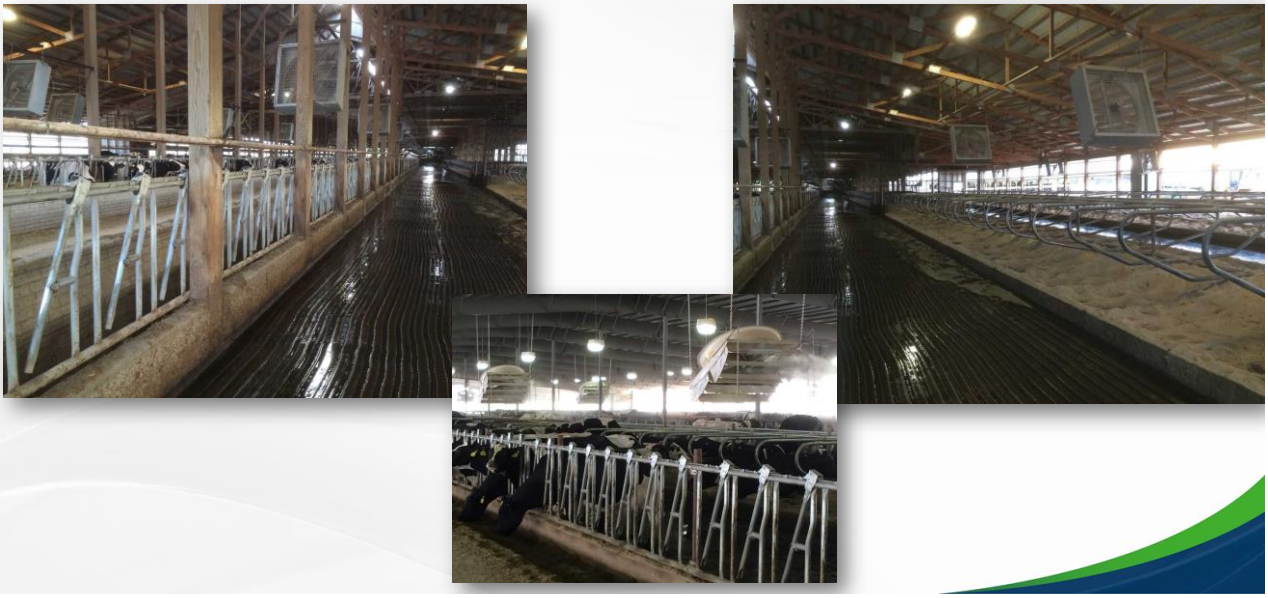
31

The effects of an evaporative cooling system on reducing heat load in lactating dairy cows

J. R. Johnson[1], M. J. Wolf[2], J. McBride[2], and M. J. Brouk[1]
[1]Kansas State University, Manhattan, KS
[2]VES Environmental Solutions, Chippewa Falls, WI

33

Conventional/Soaker vs Hybrid Tunnel/HPF

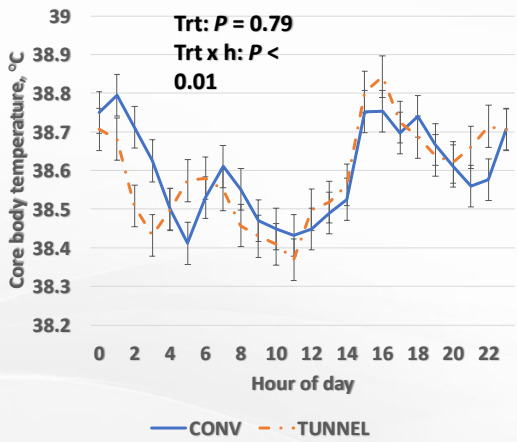


34

High Pressure Fog (HPF) Application

35

CBT of Tunnel/HPF vs Conventional/Soak



	Treatment			
CBT, °C	CONV	TUNNEL	SE	*P*-value
< 38.6	13.4	14.2	1.08	0.20
≥ 38.6	7.9	7.3	0.59	0.16
≥ 39.0	2.7	2.5	0.59	0.69

No Statistical Difference in CBT

36

Physiology & Behavior Comparison

	Treatment			
Item	**CONV**	**TUNNEL**	**SE**	***P*-value**
Respiration rate, BPM	**57.9**	**52.0**	**2.2**	**< 0.01**
Udder temp, °C	**34.5**	**33.2**	**0.3**	**< 0.01**
Lying time, h/d	**10.8**	**11.8**	**0.3**	**< 0.01**
Lying bouts, n/d	**11.8**	**10.8**	**0.6**	**0.01**
Lying bout duration, min	**57.5**	**69.3**	**3.3**	**< 0.01**

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Laying Time by Time Range

	Treatment	
Item	CONV	TUNNEL
Lying time, %		
0400-1000 h	51.6[a]	58.5[b]
1200-1800 h	42.7[a]	54.4[b]
2000-0200 h	49.2[a]	57.7[b]
Lying bouts, n/ time period		
0400-1000 h	2.9	3.1
1200-1800 h	2.7	2.6
2000-0200 h	2.8	3.1
Lying bout duration, min		
0400-1000 h	76.9	80.4
1200-1800 h	61.8[a]	90.1[b]
2000-0200 h	76.0	77.7

38

Study Results

- Ambient temperatures were cooler than anticipated
- No differences in CBT between treatments
- TUNNEL cows increased lying time by 1 h/d
  - This equates to 0.90 to 1.60 kg (2 to 3.5 lbs) more milk per cow
- Lying bout duration was greater during the hottest part of day for TUNNEL cows
- WE MUST COOL COWS IN THE RESTING AREA

39

Feedline Soakers

- Nozzles are usually mounted 7.5-8 ft (2.3-2.4 m) apart
- 5.5 ft above cow alley to reduce wind currents from carrying water to feed or beds
- Preferably protected by angle or "C" channel
- Pattern should cover cow from withers to hooks
- 1-1 ½ minutes/treatment is sufficient to soak cow to skin

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Soaker System Set Points

- 75 - 82° F once every 15 minutes
- 83 - 87° F once every 10 minutes
- >87° F once every 5 minutes

(Effectiveness of Cow Cooling Stategies Under Different Environmental Conditions, Western Dairy Management Conference March 12-14, 2003 Reno, NV)

- 1-1 ½ minute Duration
- TeeJet nozzle (0.7-1.1 gal/min)
- Automated controls to assure cooling strategy accounts for dynamic environmental conditions
- Recirculation fans in holding pens must accommodate ceiling height & crowd gate restrictions
- Do not park cows without 400 fpm (2 m/s) airflow & ambient temperature drop strategy. Including connecting links, palpation rails or hoof trimming areas.

42

Comparison of Cooling Strategies

Soaker

- Evaporative cooling
- Applicable in most climates
- Cooling water adds to lagoon volume
- Creates more slurry in alleys potentially slashed onto udder increases mastitis risk
- Applied at feedline & holding pen

HPF

- Convective Cooling
- Primarily arid to semi-arid climate
- Moisture removed from the facility by exhaust fans
- Does not increase slurry volume
- Targeted cooling over beds or parlor/holding pen

43

Comparison of Cooling Strategies

Soaker

- Requires 400 fpm (2 m/s) air flow
- Simpler delivery system
- Lower maintenance
- Often no cows at feedline

HPF

- More sophisticated system & control
- Requires 400 fpm (2 m/s) air flow
- Air exchange strategy required
- Pump & nozzle maintenance

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Goals of Effective Cooling System

- Fresh Air Introduced at a Rate Appropriate for Climate Conditions
- Exit Strategy for Humidity & Fouled Air (active or passive)
- Directed to the Cow's Living Space Especially Freestall Bed & Holding Pen
- Minimize the Increase of Core Body Temp (CBT) in Intensity & Duration
- Should Daily Return the Cow to Her Basal CBT Before the Next 24 Hr Interval

45

Goals of Effective Cooling System

- Should Not Increase Thermal Heat Index (THI)
- Reduce Potential Disease Risk
- Cost Effective for the Local Climate
- Parlor/Holding Pen Cooling Strategy Very Investment Capital Effective (dry cow cooling too)
- Enhance Employee Working Environment

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Thank You

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