Energy Conservation for Farm Coops

Scott Sanford

Sr. Outreach Specialist

University of Wisconsin

Focus on Energy / Rural Energy Issues

Agenda

- Lighting
- Space Heating
- Grain drying
- Grain handling
- Motors
- Efficiency Grants

Old Technology versus New

- Incandescent & Halogen

  Replaced by

- Compact Fluorescent Lamps (CFL)
  - 75% less power than incandescent lamps
  - Excellent color rendering qualities
    - CRI – 82
  - 6 to 10 times longer life than incandescent
    - Average Life: 6,000 to 10,000 hours
  - Low starting temperatures
    - Down to -20°F, older models to 32°F or 0°F
    - Warm up to get to full output
  - Install in sealed fixtures in dusty/moist areas
  - For enclosed fixtures - use rated lamps.

$2.00 Mail-in Cash-Back Reward from Focus on Energy
(Until June 30, 2005)

Old versus New

- T-12 Fluorescent

  Replaced by

- T-8 Fluorescent
  - Similar to popular T-12 lamps but 1” versus 1.5” diameter
  - 20% more Lumens per watt than T-12 lamps
    - T-8 & T-12 provide about the same output per bulb (~5%)
  - 65% longer life than T-12 lamps
    - Average Life: 15,000 to 20,000 hours versus ~ 10,000 hours
  - Ballasts 40% more efficient (electronic versus magnetic)
  - Start temperatures down to 0°F (Depends on ballast)
    - -20°F for High Output version
  - No Flickering – T-12 flickers >50°F

Old versus New

- Mercury Vapor Lamps
  - Lamp depreciation – 50% every 5 years

  Replaced by

- High Pressure Sodium
  - 150% more efficient
    - 2.5 watts MV = 1 watt HPS
  - Yellow/orange light
  - CRI similar to Mercury Vapor lamps

- Pulse-Start Metal Halide
  - Uses 50% less energy
  - Good color rendering characteristics
  - Warehouses, high ceiling retail space

Comparison of Lamp Types

Lamp type	Lumens/watt	Average life (hrs)	Color	CRI	CT (K)	Starting Temp. (F)	Instant On	Wattage range
Incandescent	7-20	1000	White	100	2800	>- 40°F	Yes	25-200
Halogen	12-21	2-6000	White	100	3000	>- 40°F	Yes	45-500
Mercury Vapor	26-39	24,000	Bluish	15-50	3800-5700	-22°F	No *	50-1000
Compact Fluorescent	45-55	6000 to 10,000	White	82	2700	-20°F or 0°F	Yes *	14-29
T-12 HO Fluorescent	30-70	9000 – 12,000	White	52-90	3000 – 5000	-20°F	Yes	25-110
Metal Halide	41-79	10,000 - 20,000	Bluish	65-70	3000-4300	-22°F	No *	150 -1000
Pulse Start Metal Halide	60-74	15,000 - 32,000	Bluish	62-75	3200-4000	-40°F	No *	100 - 750
T-12 (1.5”) Fluorescent	62-80	9000 to 12,000	White	52-90	3000-5000	50°F	Yes	30-75
T-8 HO Fluorescent	81	18,000	White	75	3000-5000	-20°F	Yes	86
High Pressure Sodium	66-97	24,000	Yellow-orange	22-70	1900-2100	-40°F	No *	35-1000
T-8 (1.0”) Fluorescent	76-100	15,000 - 20,000	White	60-86	3000-5000	0°F or few 50°F	Yes	25-59

* Requires warm-up to reach full output

Full Cut-off Reflector

More light in target area

= Lower wattage needs

Hubbell SkyCap

GE Sky-Guard

RAB Down Blaster

Standard HID Fixture with Refractor

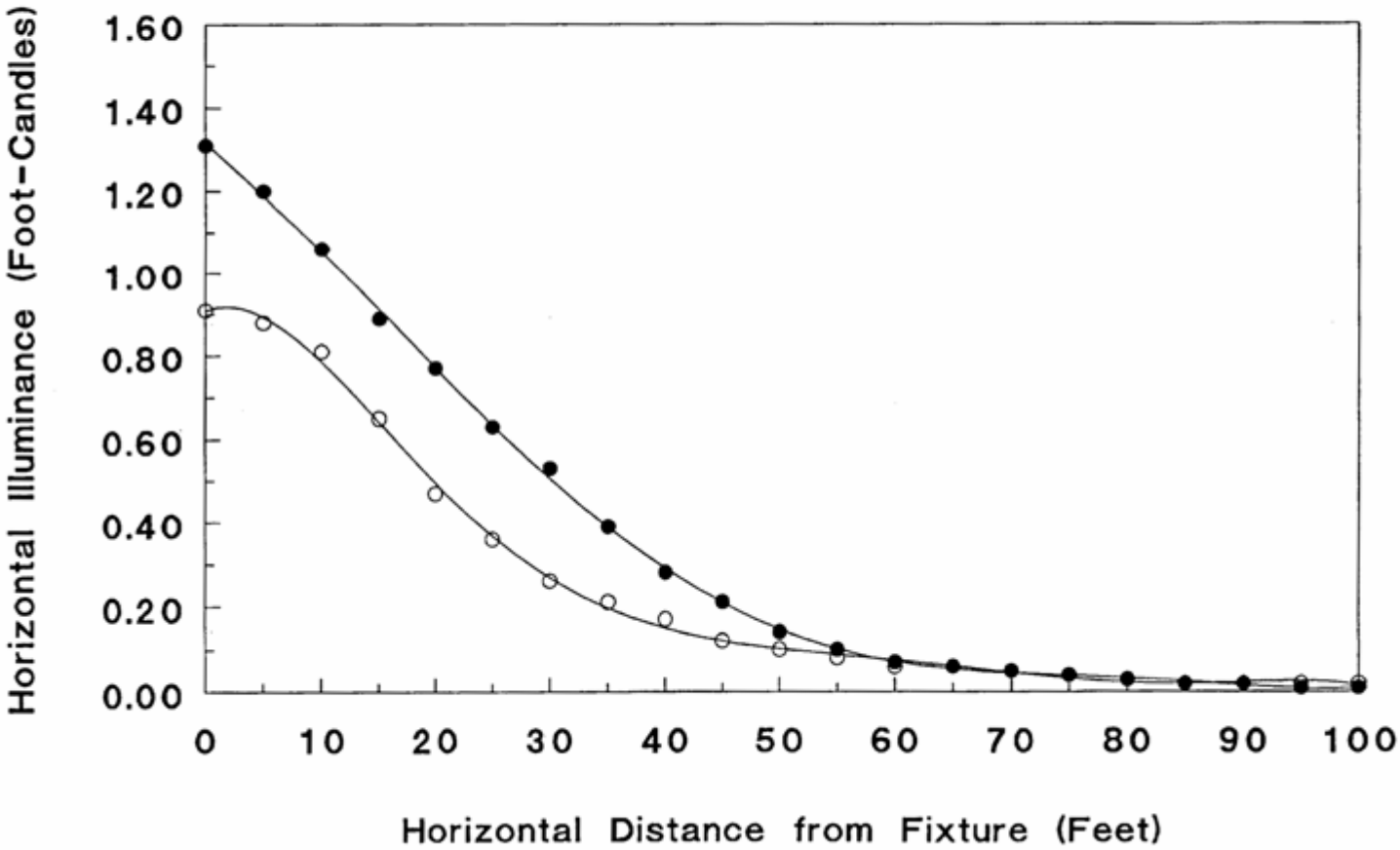
30% of light goes up

Light Distribution of MV Luminaire

NEMA Type: Shielded vs. Unshielded

○ 175W MV Unshielded

● 175W MV Shielded



Hubbell Skycap Retrofit (25' MH) results in 47% more light on the ground in the zone 0 - 100 ft.

Courteous of Outdoor Lighting Associates, Inc – Ames IA

Yard Light Comparison

Lamp Type		Lumen Output	Operation Cost *
175W	Mercury Vapor	6800 L (4760 L @ 70%)	$ 78
70W+	HP Sodium	5450 L	$ 32
100W	HP Sodium	8550 L	$ 46
100W	PS Metal Halide#	6200 L	$ 46
150W	PS Metal Halide	8600 L	$ 70

* Includes Ballast energy usage, assumes $0.085/kWh, 12 hours of operation per day for 365 days

+ 70w HP Sodium lamp with shield will provide approximately the same light at the ground as 175w Mercury Vapor lamp un-shield.

PS = Pulse Start

Outdoor Lighting Controls

Is lighting required all night?

- Control with Clock / timer
- Photo / Motion Sensor
- DPN Half-night photo sensor
  - Measures night length daily and turns on light 1st half of night.
  - Replaces standard photo sensor
  - Cost ~ $30 - $50
  - Thomas & Betts Corp product
    - Contact electrical supply house
    - Part Number: DPN124 2.6 TMGN

Outdoor Lighting – Low Activity Areas

- Motion/photo sensors with halogen lamps
  - Security / work locations with short duration activities
    - Lighting needed less than 3 hours per night (25% of the time).
  - Locations where instant on is required
  - Payback 1-2 years

Disposal of Fluorescent & HID Lamps

- All lamps contain Mercury (except incandescent)
- WI State law requires
  - All businesses to recycle
  - Dispose as Hazardous waste
- Recycling
  - Distill mercury, smelt metals, glass reused
- Contact:
  - Town or County recycling Coordinator

Space Heating Needs

- High Efficiency heaters –
  - Gas - 90% plus efficiency
  - Oil – 80% plus efficiency
  - Condensing furnaces
  - Forced Air or Hydronic Systems

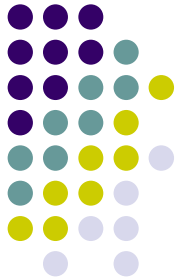
- Maintenance
  - Change filters
  - Clean burners
  - Belts

Radiant Heating

- Use in large volume areas or high ceilings
- Heats objects not air
  - Re-radiated heat warms air
- Quick heat recovery
- Localized heating within warehouse
- Saves energy

Grain Dryer

- Energy Efficiency



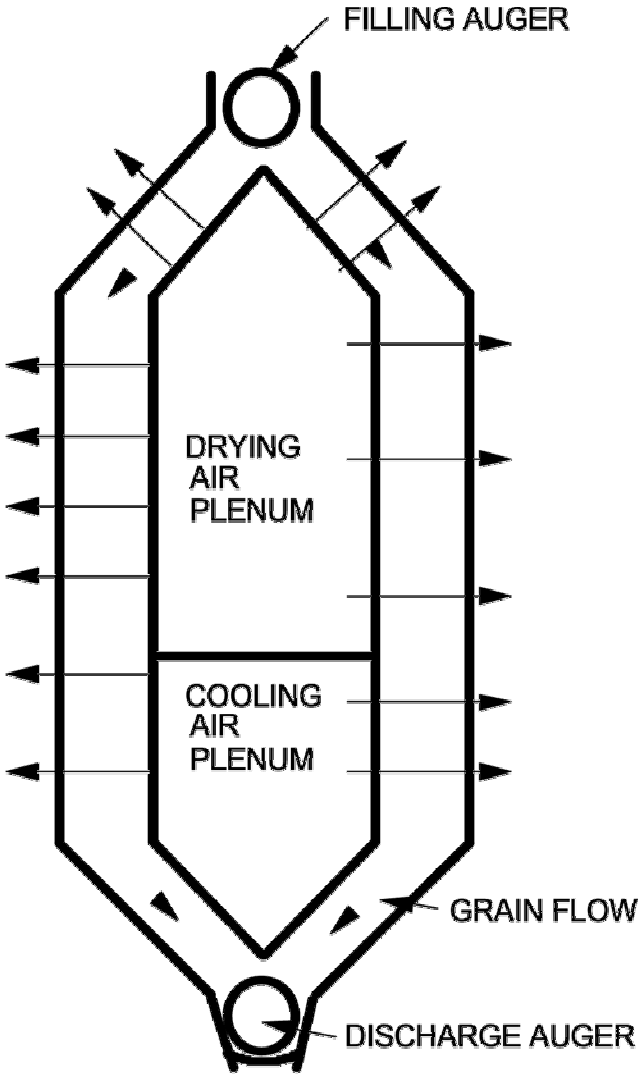
- BTU per pound of water removed from grain
- No dryer performance standards
- Limited independent dryer test data
- Limited research data

Rule of thumb fuel usage

- Cross-Flow High-Temp. dryer
  - 0.02 gallon propane/ bushel / % moisture removed
  - 0.018 Therms NG / bushel / % moisture removed
  - 0.01 kWh Electricity / bushel / % moisture removed

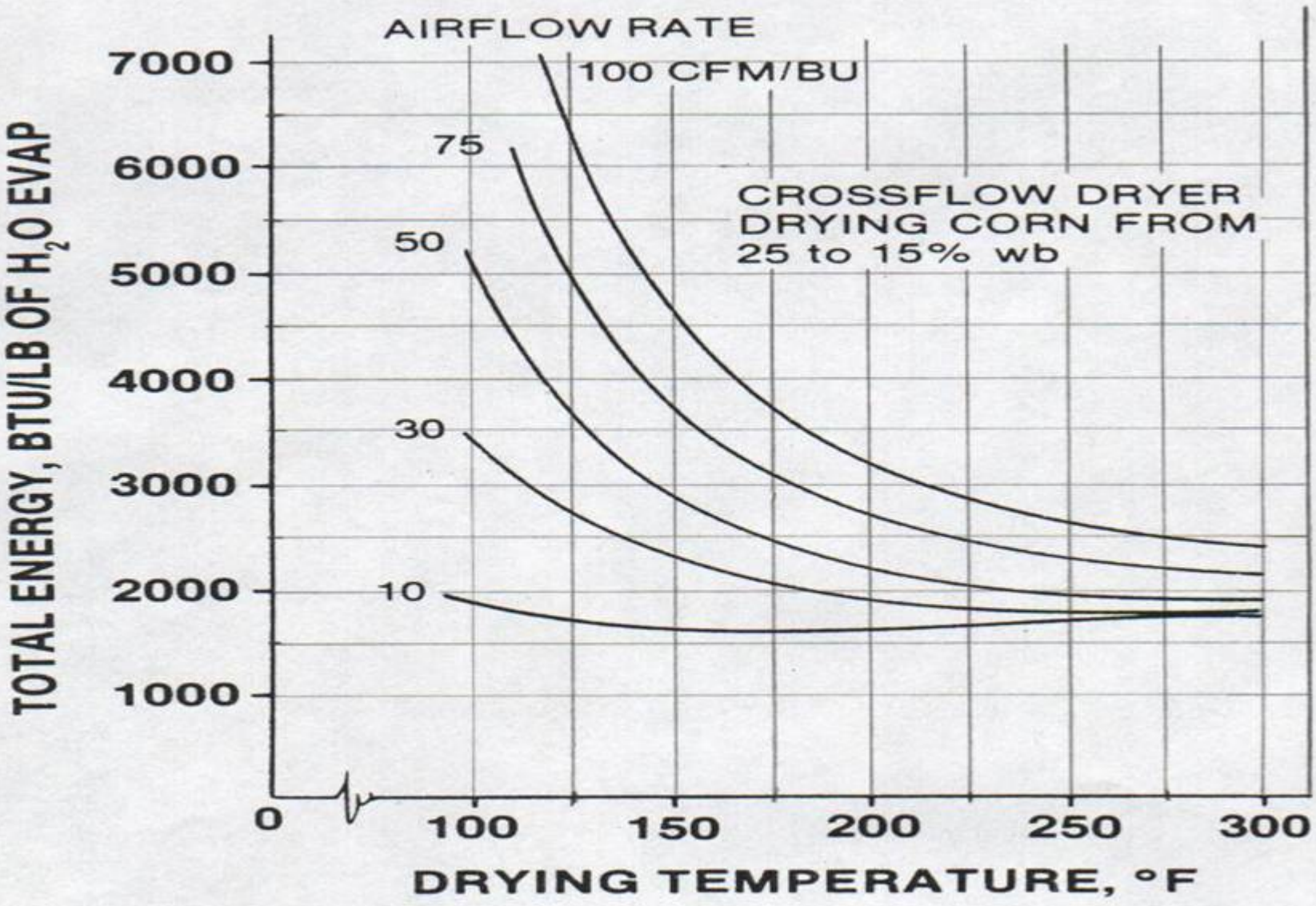
Dry Clean Grain

- Screen before drying
- Screen before storage
  - Less volume to dry
  - Increased air flow in dryer
  - Less materials to plug screens and aeration floors



Conventional Crossflow Column Dryer
In-Dryer Cooling

Cross-Flow Column Dryer



Cross-flow Column Dryer
Heat Recovery Options

Scavenge Heat from hot corn to pre-heat inlet air to dryer

- Reduces energy usage 10 to 20%

- Duct exhaust air from cooling section to air intake of heater

And (optional)

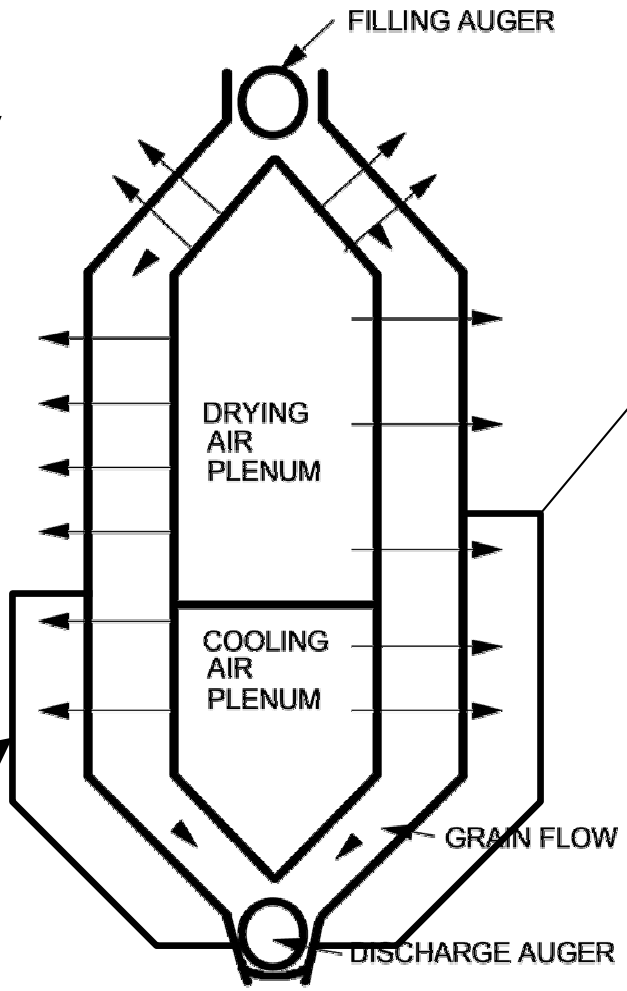
- Recovered from lower portion of drying section of dryer

Or

- Reverse air flow through Cooling Section of dryer

Duct Work for Heat Recovery

Retro-fitting Dryer
with Heat Recovery



Duct to Dryer
Air Intake

Heat Recovery
Cooling section

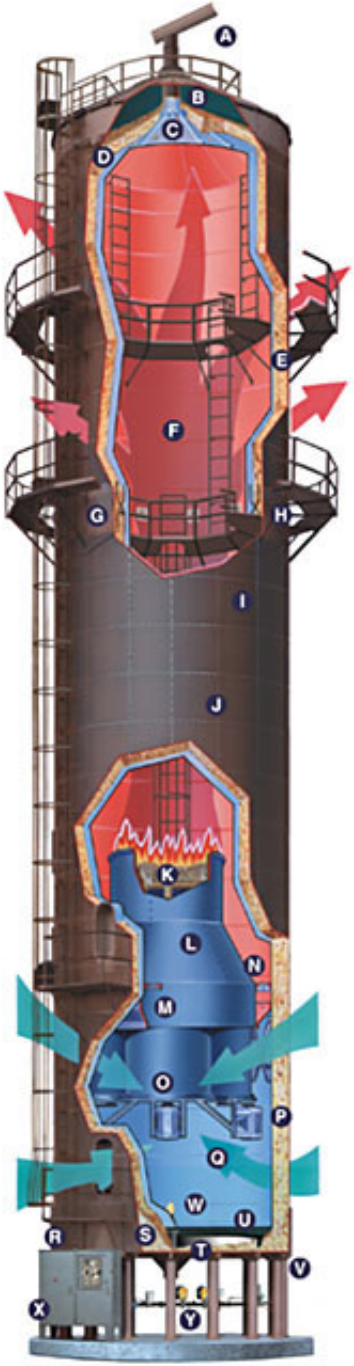
Heat Recovery
Lower Heating
Section

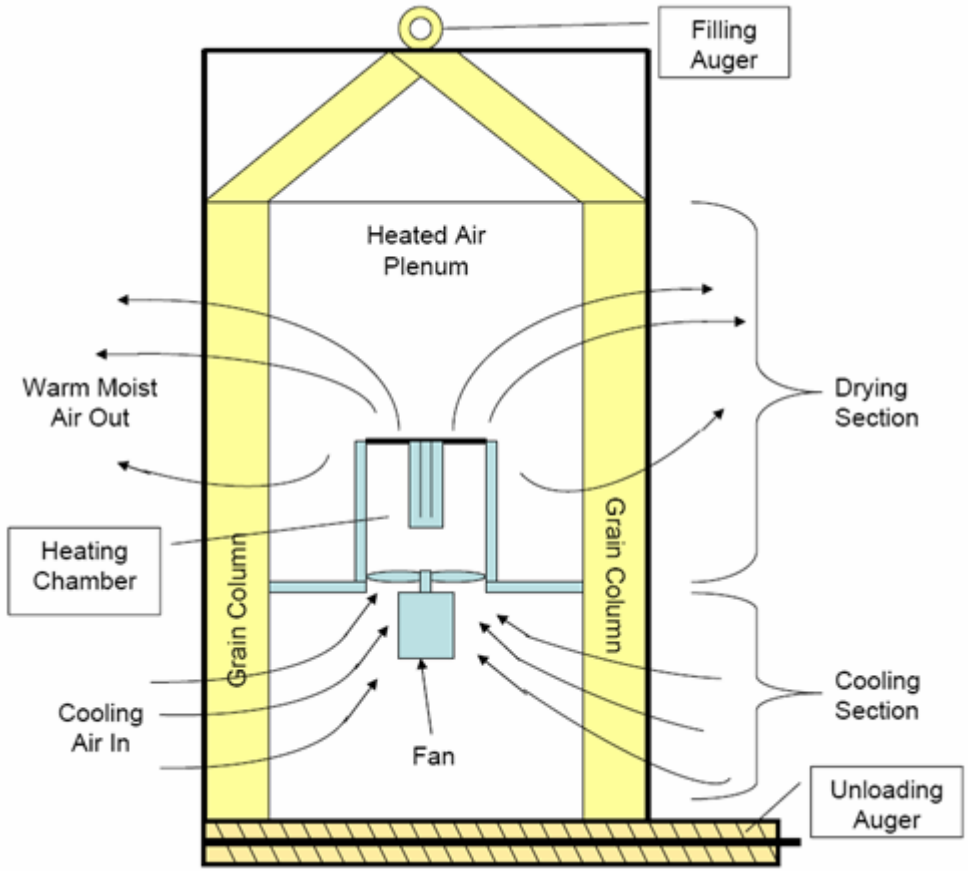
And

Cooling Section

Access needed for
cleaning screens

Reverse Flow Cooling

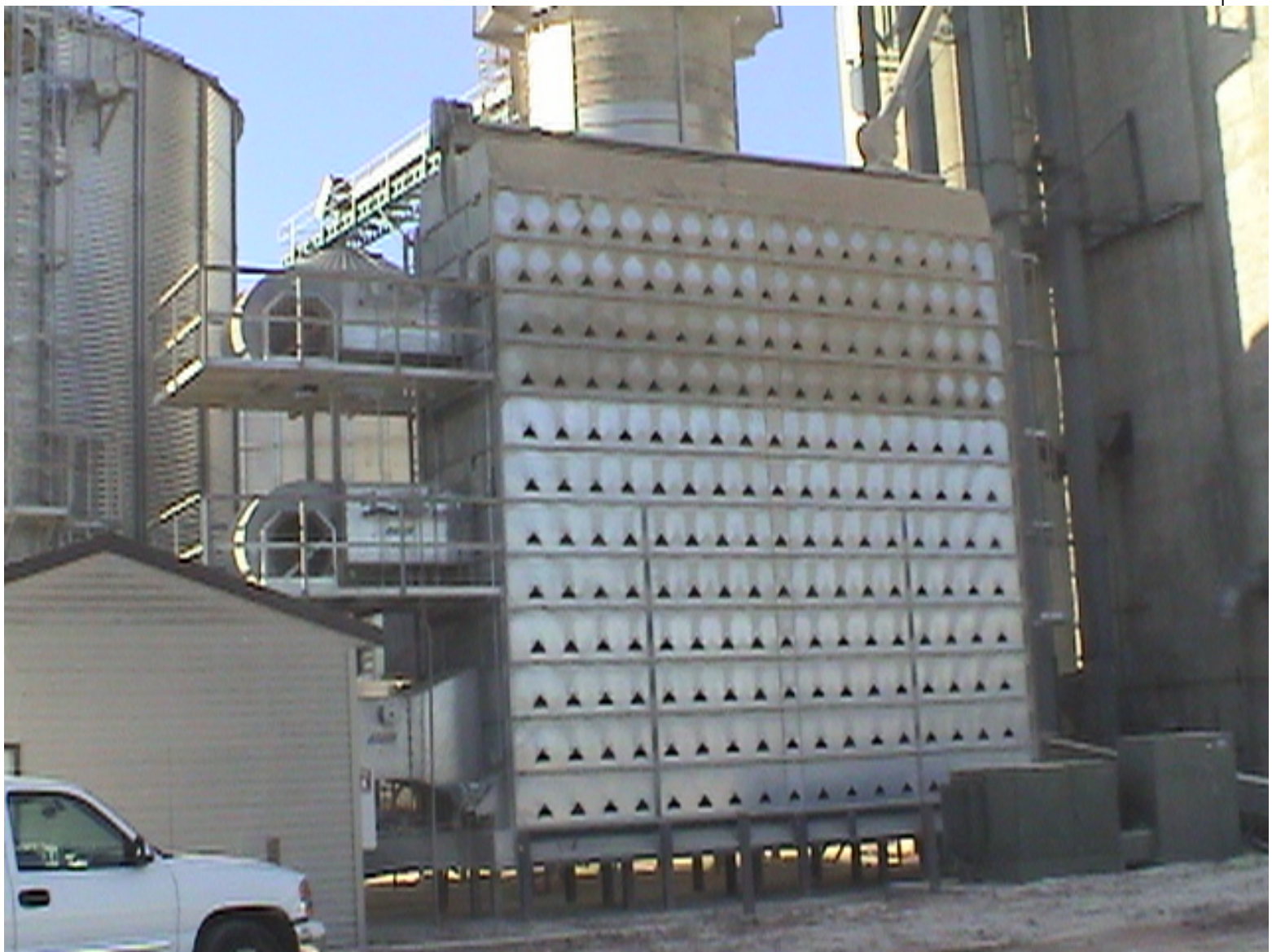




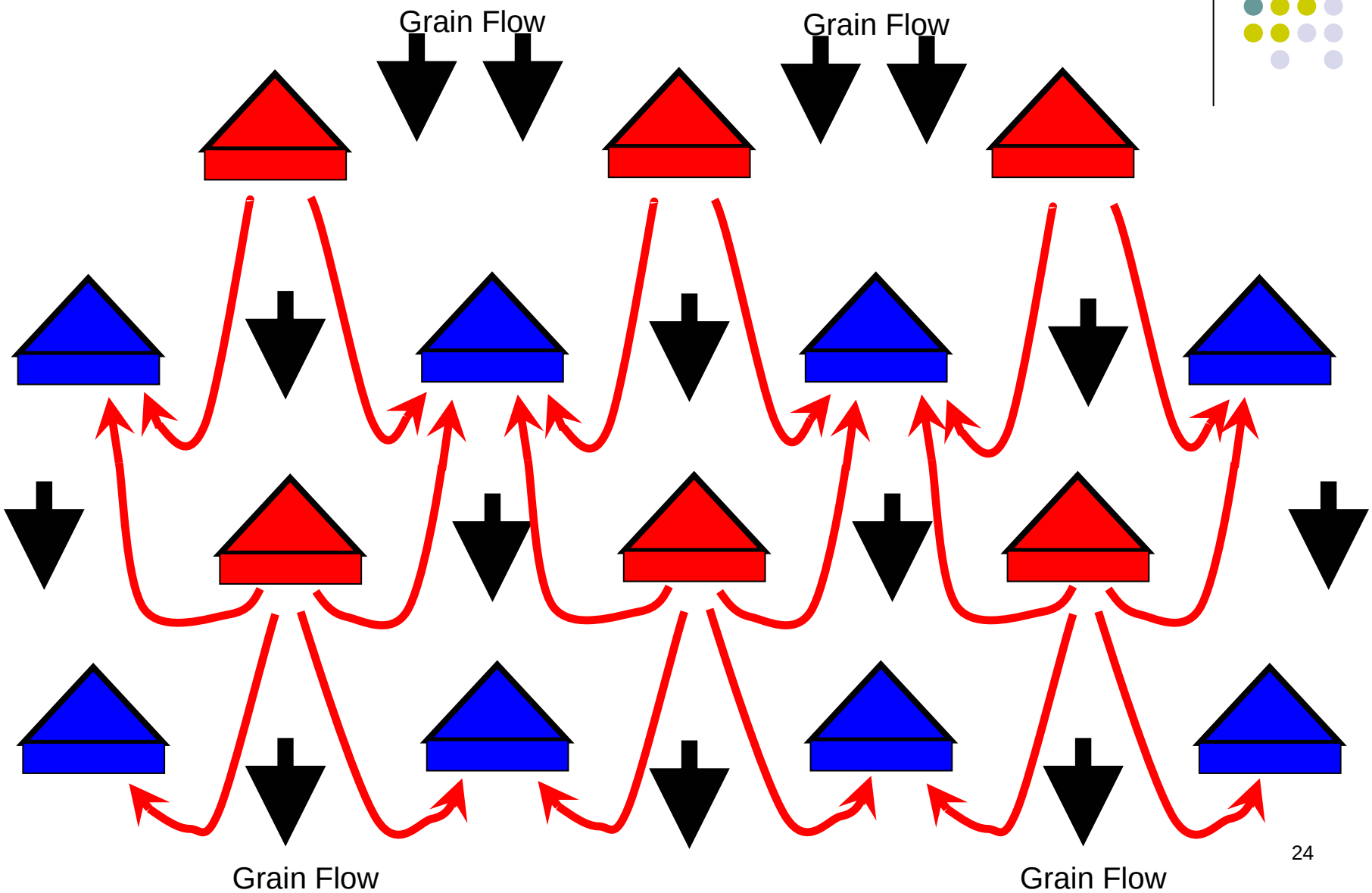
Courtesy of Zimmerman Dryers

Mixed-Flow Dryer

Mixed Flow Dryer – 900 Bu/hr



Mixed Flow Dryer - Air Flow Patterns



Mixed-Flow Column Dryer

- High efficiency column dryer – 2050 Btu/# H_2O
  - Up to 35% more efficient than typical cross-flow dryer
- No screens to plug
- Handles wide range of seed sizes
- Continuous flow process
- Multiple heating zones possible
- Uniform drying of seeds – higher grain quality
- Can be used with in-bin cooling or dryeration
- Not widely used in Midwest,
  - Predominant in Europe, Asia, Latin American
- Disadvantage:
  - Higher cost ???
  - Fast payback on additional investment – 1 to 3 years

In-Bin Continuous Flow Dryer Options

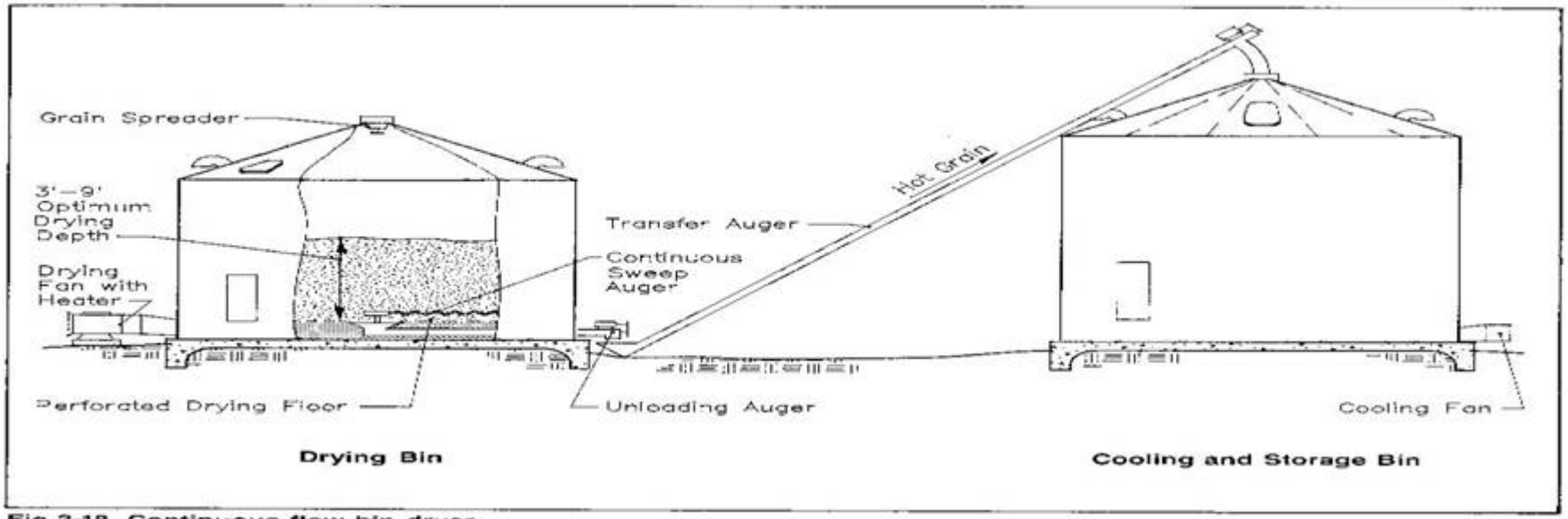


Fig 3-18. Continuous flow bin dryer.
A transfer auger moves grain intermittently to cooling in storage bins.

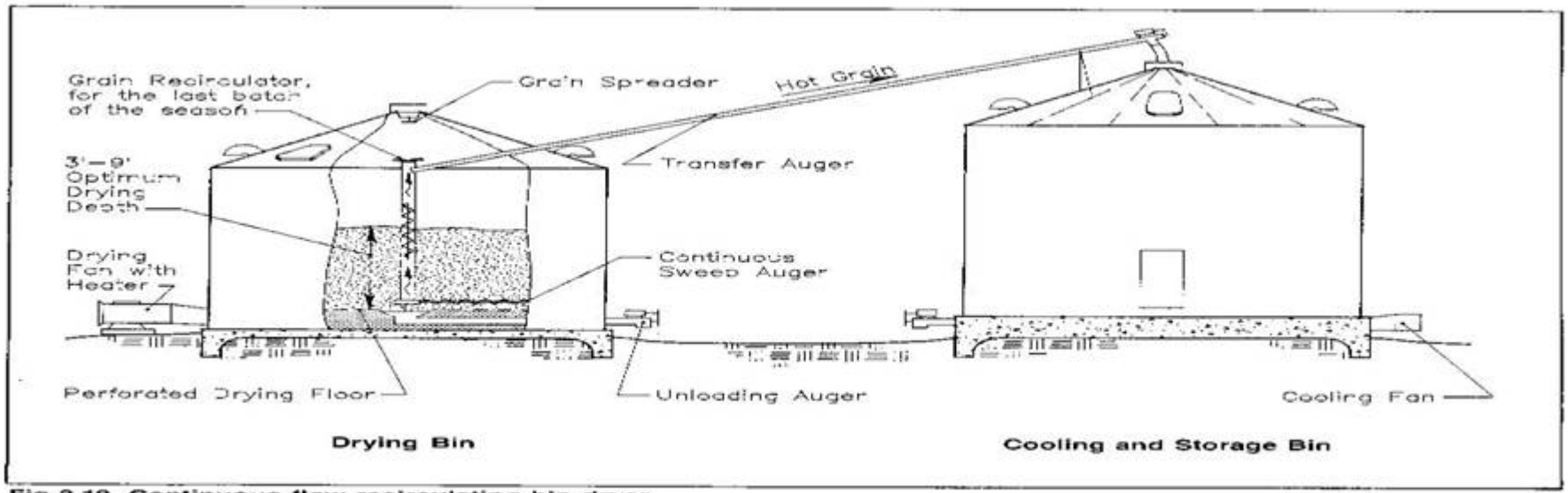
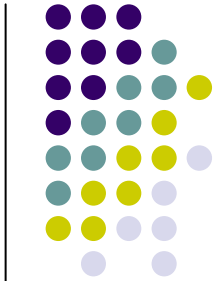


Fig 3-19. Continuous flow recirculating bin dryer.
At least one more storage bin equipped to properly cool hot grain is common.

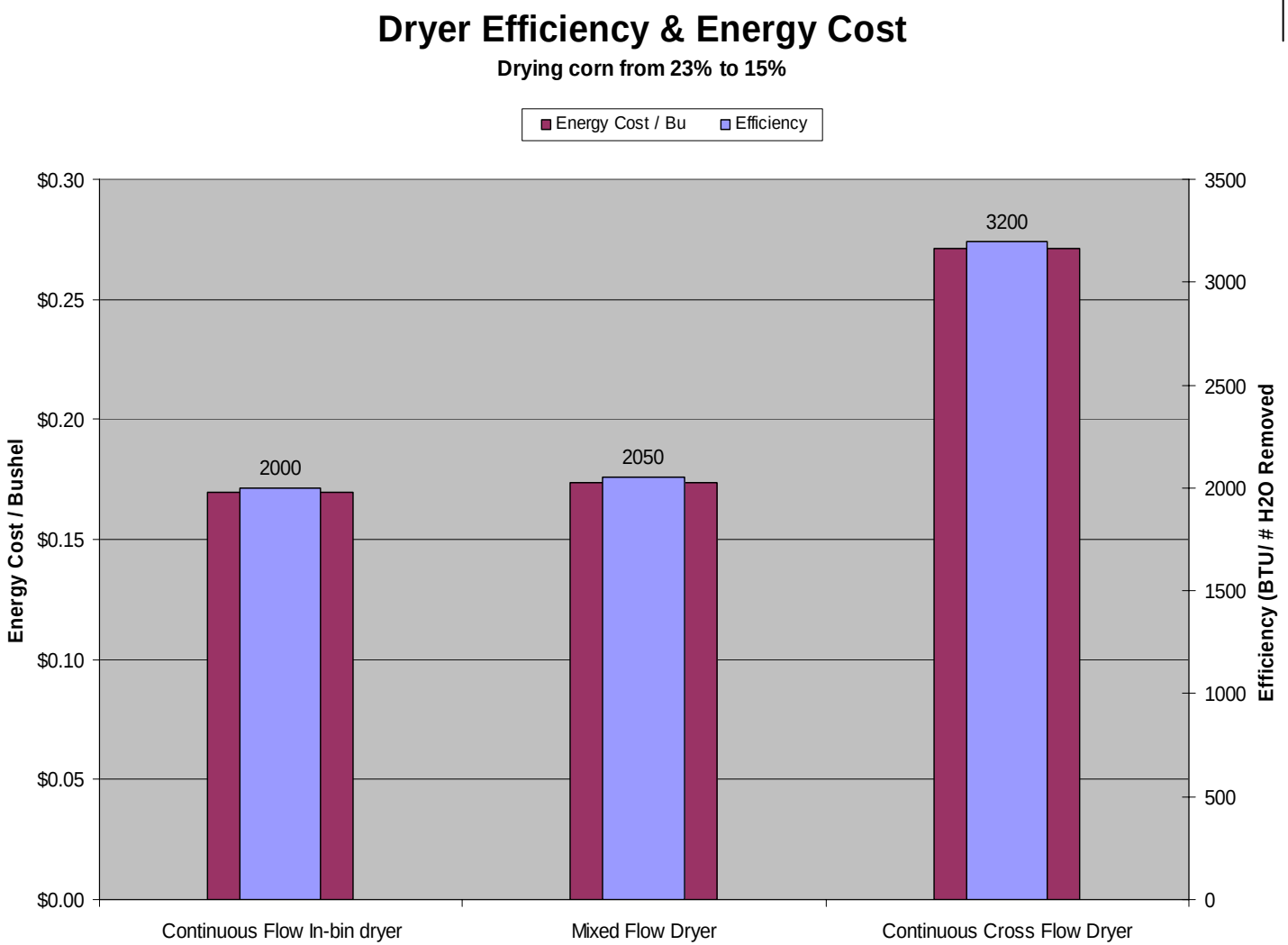
In-Bin Continuous Flow Dryer



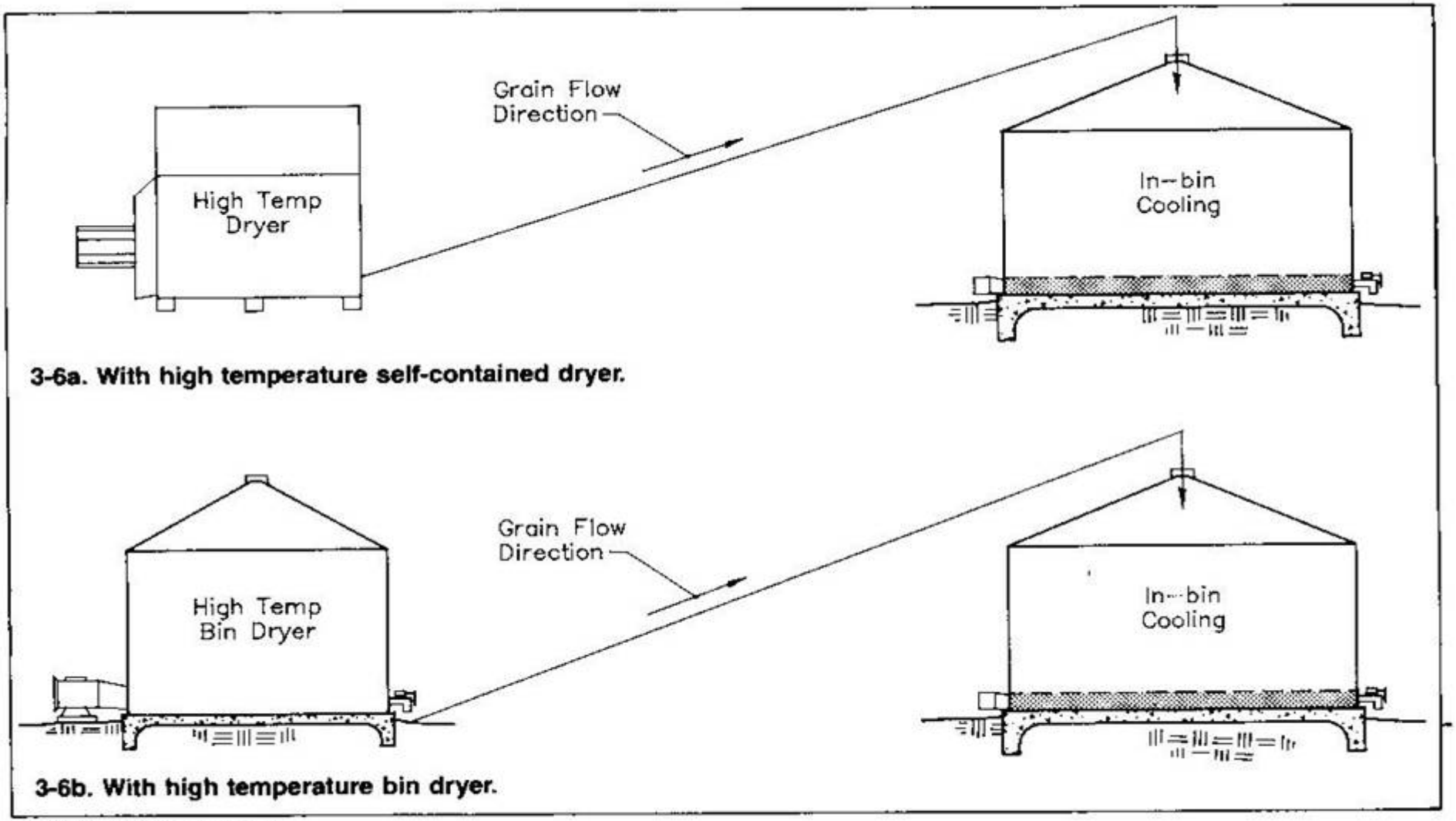
- Most energy efficient high temperature dryer
  - Counter Flow exchange of energy
  - 35 to 40% more energy efficient than cross-flow dryer
- Superior grain quality (MSU test report)
  - Uses in-bin or dryeration cooling
- No wet bin needed
- Dry grain removed from bottom
- Less over drying of grain
- Fully Automated drying
- Capacity – 8000 to 17,000 bu/day (300 to 700 bu/hr)
- System can be retrofitted to an existing bin
- Bin useable for storage at end of drying season

- Disadvantages
  - Capacity can not be expanded easily
  - Fines must be removed from bin floor every 3-4 days
    - Cleaning grain entering dryer lengthens cleaning interval

Propane: $1.40/gal
Electric: $ 0.085/kWh



In-Bin cooling

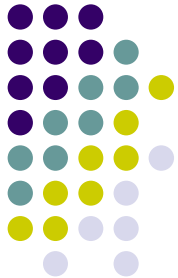


3-6a. With high temperature self-contained dryer.

3-6b. With high temperature bin dryer.

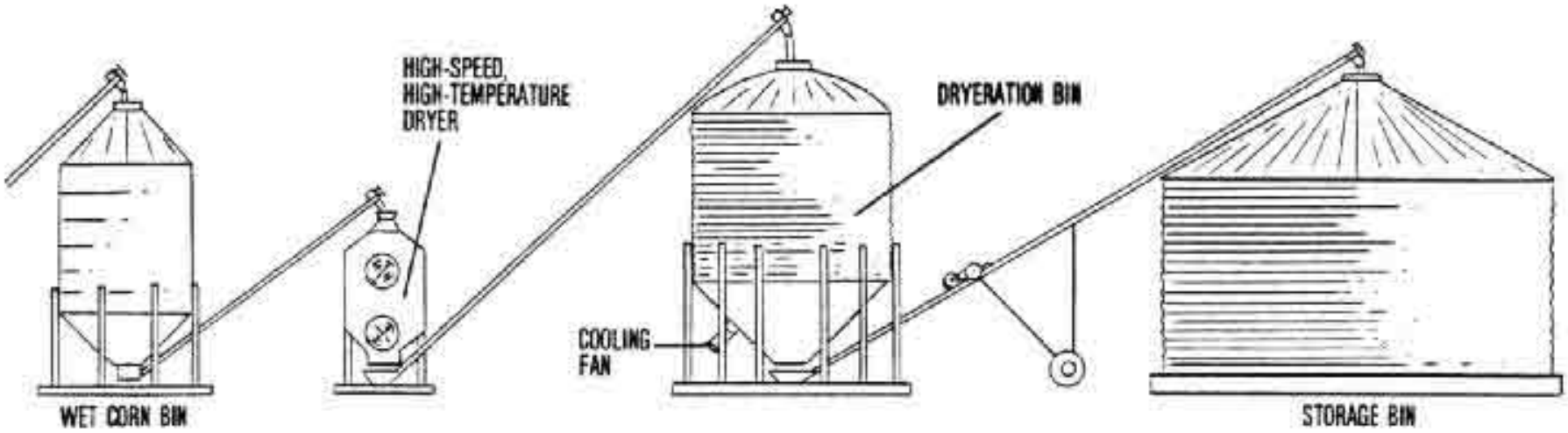
Fig 3-6. In-bin cooling.
Grain dried in a high temperature dryer or bin and cooled in a separate storage.

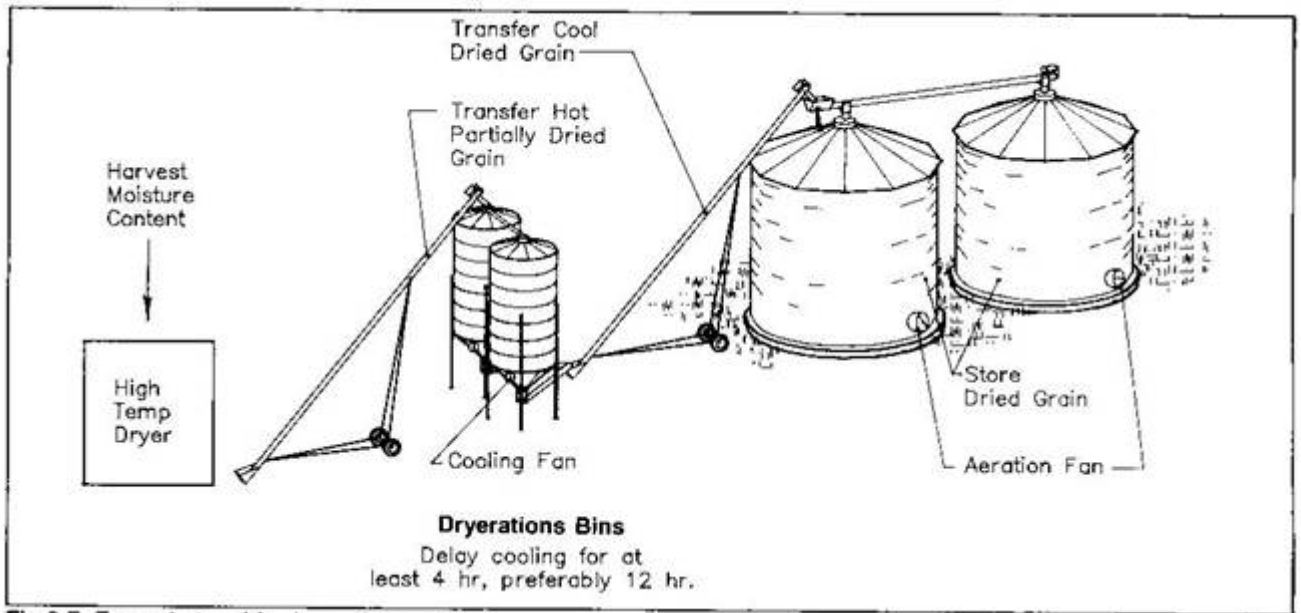
In-Bin Cooling



- Used with high-temperature full-heat dryer
  - Continuous-flow or batch
- Transfer hot grain (120 to 140°F) to storage bin
- Moisture: 1 to 1.5% above desired storage moisture
  - Remainder of drying occurs as grain cools
  - Moisture reduction: ~0.2% per 10°F of temperature decrease
- Start cooling fans immediately
- Reduce fuel costs at least 10-15%
- Increase dryer capacity about 33%

Dryeration


HIGH-SPEED,
HIGH-TEMPERATURE
DRYER
DRYERATION BIN
COOLING
FAN
WET CORN BIN
STORAGE BIN


Transfer Cool
Dried Grain
Transfer Hot
Partially Dried
Grain
Harvest
Moisture
Content
High
Temp
Dryer
Cooling Fan
Store
Dried Grain
Aeration Fan
Dryerations Bins
Delay cooling for at
least 4 hr, preferably 12 hr.

Dryeration

- Transfer hot grain (120 to 140°F) to cooling bin
- Moisture: 2-3% above storage moisture content
- Grain allowed to “Temper” for 4 to 12 hours
- Cool grain
  - Remainder of drying occurs as grain cools
  - Moisture reduction: ~0.4% per 10°F of temperature decrease
- Transfer grain to storage bin

- Energy savings: 15% - 25%
- Dryer capacity: increases up to 70%
- Improved grain quality
  - Fewer stress cracked kernels and breakage

	Cracks	Breakage
Rapid cooling	43.6%	11.3%
Dryeration	7.6%	6.7%

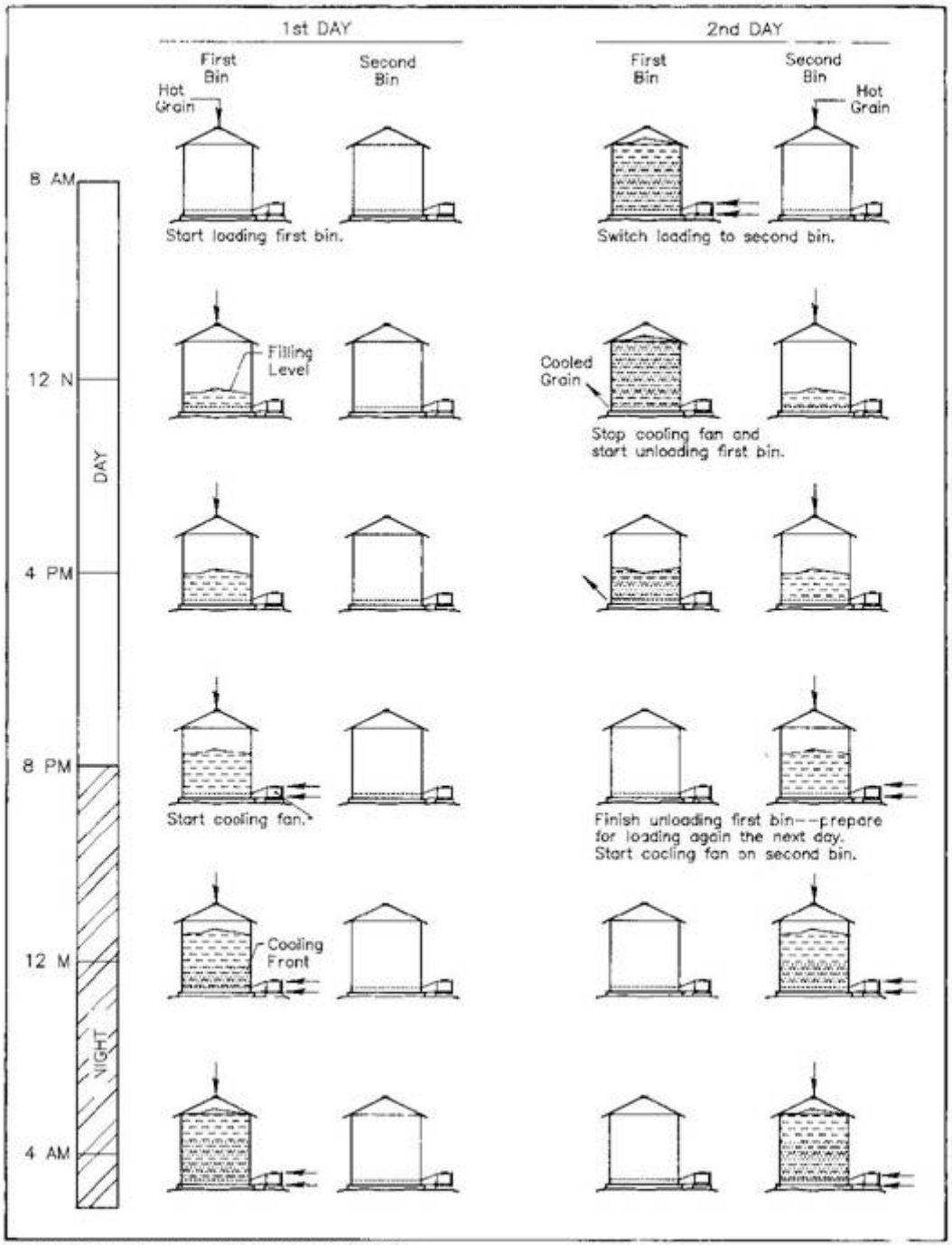


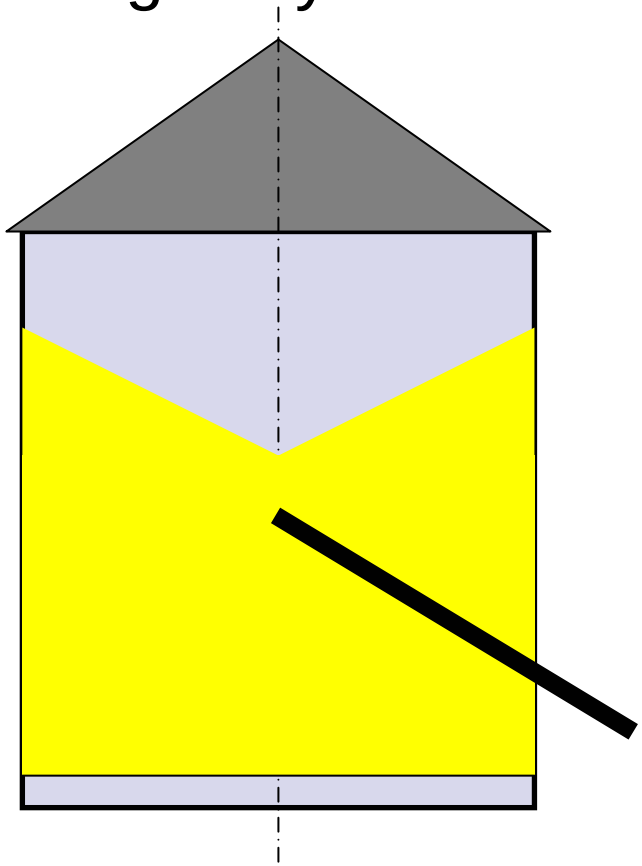
Fig 3-8. Typical dryeration 24 hr cycle with 2 bins.

Dryer Maintenance

- Keep screens and aeration floors clean
- Check and tighten belts
- Check burner operation – blue flame
- Calibrate moisture sensors
- Check that bearing mountings are tight
- Lubricate as recommended by mfg.

Side Discharge from Grain Bins

- Reduce handling costs
- Faster loading
- Put gravity to work



- Discharge must extend to center of bin

Motor Matters

- Premium Efficiency Motors (3 Phase) (1997 and later)
  - 2-4% more efficient
- Planned Replacement / Rewind Decisions
  - Rewind vs new EPAct vs Premium Efficiency
  - Resources:
  - http://eereweb.ee.doe.gov/industry/bestpractices/software.html#mm
  - www.motorsmatter.org/

- High Efficiency Single Phase motors
  - 4% to 19% higher efficiency
  - ¼ HP to 5 HP motors
  - Baldor - Premium Efficiency – 1/4 HP to 5 HP
  - Leeson - **WATTSAVER® -** 1/3 hp to 2 HP

- Motor / Drive Maintenance
  - Belts, roller chains, drive couplings, gear boxes

Energy Efficiency Grants

Focus on Energy

- Utility must be participating in program
  - All investor owned utilities, Alliant, WPS, WE Energies…
- Free energy audits
- www.focusonenergy.com
- Contact Agricultural consultant
  - 1-800-762-7077

- 2002 Farm Bill Energy Efficiency Grants
  - Application period typically - March to June
  - Minimum grant $2500 – up to 25% of project cost

Renewable Energy

- Ethanol – truck fuel
- Bio-Diesel – truck fuel
- Wind Turbines - electricity
- Thermal Solar - space heating
- Bio-gas - space heating/ corn drying /electricity

Contact Information

Scott Sanford

Sr. Outreach Specialist
Focus on Energy / Rural Energy Issues

Biological Systems Engineering

University of Wisconsin – Madison

608-262-5062

sasanford@wisc.edu

Wisconsin Energy Efficiency and Renewable Energy

www.uwex.edu/energy