Understanding Degree Days

The degree day system predicts heating fuel consumption based on outdoor temperature. It's commonly used for automatic oil delivery scheduling to estimate when a customer will need a refill.

What is a degree day?

A **degree day** measures heating demand:

- **Heating Degree Day (HDD)**: Measures how cold it is relative to a base temperature (usually 65°F)
- **Calculation**: For each day, HDD = max(0, Base Temp - Average Outdoor Temp)
- **Accumulation**: Sum HDDs over time to estimate fuel consumption

Example:

- Base temperature: 65°F
- Average outdoor temperature: 40°F
- HDD for that day: 65 - 40 = 25 HDD

If it takes 5 HDD to burn 1 gallon of oil (K-factor = 5), then after 100 accumulated HDD, the customer has used approximately 20 gallons.

Key formulas

Daily heating degree days

$$ HDD_{day} = \max(0, T_{base} - T_{avg}) $$

Where:

- T_{base} = Base temperature (typically 65°F)
- T_{avg} = Average outdoor temperature for the day

Accumulated degree days

$$ HDD_{accumulated} = \sum_{i=1}^{n} HDD_i $$

Sum all daily HDDs since the last delivery.

K-factor (consumption rate)

The K-factor represents the relationship between degree days and gallons consumed:

$$ K = \frac{HDD}{gallons} $$

Example: If a customer used 200 gallons over 1000 HDD, then:

$$ K = \frac{1000}{200} = 5.0 $$

So it takes 5 HDD to consume 1 gallon.

Estimating gallons used

$$ gallons_{used} = \frac{HDD_{accumulated}}{K} $$

Remaining fuel estimate

$$ remaining = capacity - gallons_{used} $$

Where capacity is the effective tank capacity (total capacity minus a reserve buffer).

Triggering a delivery

Dispatch a delivery when:

$$ remaining \leq reserve_{threshold} $$

Typically, reserve threshold is 25-30% of capacity to avoid run-outs.

Configuration steps

1. Set base temperature

- **Standard**: 65°F for most residential heating
- **Adjustments**: Some buildings may use 60°F or 68°F based on insulation, thermostat settings, or climate
- **Configuration**: Set at the service or system level

2. Determine K-factor

Initial K-factor (before delivery history):

- Use industry defaults: 4.0–6.0 for typical homes
- Adjust based on building type:
  - Well-insulated modern homes: 6.0–8.0 (higher K = less consumption per HDD)
  - Older, poorly insulated: 3.0–4.5
  - Commercial buildings: Varies widely; consult historical data or energy audit

Computed K-factor (after deliveries):

- After 2-3 deliveries, compute K-factor from actual consumption:
  - Gallons delivered = amount filled
  - HDD accumulated = sum of degree days between deliveries
  - $K = \frac{HDD}{gallons}$
- Update the service's K-factor with the computed value for better accuracy

3. Initialize the system

On the first delivery (or when setting up):

- **Last delivery date**: Date of most recent fill
- **Last delivery amount**: Gallons delivered
- **Starting tank level**: Estimated gallons remaining before the delivery (if known)

The system will start accumulating degree days from the last delivery date.

4. Set minimum days between deliveries

Prevent too-frequent deliveries by setting a minimum interval (e.g., 14 or 21 days). Even if degree day projections suggest a delivery is needed, the system will wait until the minimum interval passes.

5. Set trigger thresholds

Define when to dispatch:

- **Reserve threshold**: Gallons or percentage remaining (e.g., 25% or 75 gallons for a 275-gallon tank)
- **Lookahead days**: Optional; trigger delivery if projection shows run-out within X days

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Example scenario

- **Customer**: Residential, 275-gallon oil tank
- **Base temp**: 65°F
- **K-factor**: 5.0 (initial estimate)
- **Last delivery**: January 1, filled 200 gallons
- **Effective capacity**: 250 gallons (reserve 25 gallons)
- **Reserve threshold**: 75 gallons

Degree day accumulation (simplified):

- Jan 1–15: 300 HDD
- Estimated gallons used: 300 / 5 = 60 gallons
- Remaining: 250 - 60 = 190 gallons (above threshold, no delivery yet)
- Jan 16–31: Another 300 HDD (total 600 HDD)
- Estimated gallons used: 600 / 5 = 120 gallons
- Remaining: 250 - 120 = 130 gallons (still above 75-gallon threshold)
- Feb 1–15: Another 300 HDD (total 900 HDD)
- Estimated gallons used: 900 / 5 = 180 gallons
- Remaining: 250 - 180 = 70 gallons (**below 75-gallon threshold**)
- **Trigger delivery**

Degree day data sources

- **National Weather Service (NWS)**: Historical and forecast degree days
- **NOAA**: Free weather data APIs
- **Third-party services**: Commercial degree day providers with regional accuracy
- **Internal tracking**: Some systems calculate degree days from local weather station data

Your system may automatically pull degree day data but at any time you can update or modify it.

Improving accuracy

We Recompute K-factor regularly

- After each delivery, our system automatically recalculates K-factor and uses rolling averages of the last 3-5 deliveries to smooth out anomalies (e.g., vacations, extreme weather).

Adjust for customer behavior

- **Vacation adjustments**: If a customer is away, consumption drops; this should be noted within the customer account or routing notes to avoid under-delivery
- **Building changes**: New insulation, windows, or equipment can alter K-factor significantly

Combine with monitors

- If a tank monitor is installed, use **both** degree day projections and real-time level data
- Degree day provides a forecast; monitor provides ground truth
- If monitor reading diverges from degree day estimate, adjust K-factor or investigate consumption anomalies

See: Monitoring Guide

Troubleshooting common issues

Projections are too conservative (deliveries too frequent)

- **Cause**: K-factor is too low (overestimating consumption)
- **Fix**: Increase K-factor based on actual delivery history

Projections are too aggressive (customer runs out)

- **Cause**: K-factor is too high (underestimating consumption)
- **Fix**: Decrease K-factor; consider lowering reserve threshold

Degree days don't match consumption

- **Cause**: Weather data source is not local enough, or customer behavior changed
- **Fix**: Use more localized weather data by changing the weather location within the admin settings.

Sudden change in usage

- **Cause**: Equipment failure, thermostat adjustment, occupancy change, or building modification
- **Fix**: Investigate and adjust K-factor or note the anomaly; monitor closely

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Related guides

- Window Strategies — Add time-of-day constraints to degree day deliveries
- Calendar Scheduling — Combine recurring schedules with degree day
- Monitoring — Use monitors to validate degree day estimates
- Add Services — Apply degree day strategy to services
- Adding Equipment — Track tank capacity for accurate projections

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