1. User Inputs
- Gold head grade (grams/tonne)
- Particle size distributions
  - P50 value (microns)
  - P10 value (microns)
  - P80 value (microns)
- Ore mineralogy (% for each)
  - Pyrite
  - Arsenopyrite
  - Chalcopyrite
  - Sphalerite
  - Galena
  - Calcite
  - Siderite
  - Quartz
  - Feldspars
  - Montmorillonite
  - Kaolinite
- Throughput: tph or tpd
- Reagents:
 CN(kg/t),
  Lime(kg/t),
 Collector A(g/t),
 Collector B(g/t),
 Frother(mL/t)

2. Ore Classification
- Program analyzes minerals to determine ore type
  - Uses minerals >10% for sulfides
  - Minerals >5% for carbonates
  - Silicates + clays >90% for gangues

3. Flowsheet Selection
- Database retrieves relevant flowsheet based on:
  - Ore type
  - Grade & size ranges
  - Key mineral makeup

4. Process Models
A. Cyanidation
Rate of Gold Dissolution:
$d[Au]/dt = k[Au][CN^-]$
Where:
$k = A*\exp(-Ea/RT)$

Arrhenius Equation:
$k = A*\exp(-Ea/RT)$

Carbon Adsorption:
Langmuir Equation:
$q = (q_{max}*b*C) / (1+b*C)$

B. Flotation
Collection Efficiency:
$\alpha = 1/(1 + \exp((Eb/kT)))$

DLVO Theory:
$Eb = Evdw + Eedl$
$Evdw = -A*(H1*H2/(H1+H2))$
$Eedl = (2*\pi*\varepsilon o*\varepsilon r*\zeta 1*\zeta 2)*\exp(-\kappa*H) / (1+\kappa*H)$

Let me ensure I properly disclose all parameters for the DLVO equations:

For the Evdw term:

$-A*(H1*H2/(H1+H2))$

The Hamaker constant (A) can range from 10-20 x 10-20 Joules.

Particle size (H1) is usually 1-100 µm.
Bubble size (H2) is typically 50-200 µm.

For the Eedl term:

$(2*\pi*\varepsilon o*\varepsilon r*\zeta 1*\zeta 2)*\exp(-\kappa*H) / (1+\kappa*H)$

The permittivity of free space (ε_o) is a constant at 8.85 x 10-12 C2/N-m2.

The relative permittivity (ε_r) of process water ranges from 2-10.

Zeta potentials (ζ_1 and ζ_2) on particle and bubble surfaces usually fall between ±10-100 mV.

The inverse Debye length (κ) is commonly 108-1010 m-1.

The separation distance (H) in colloid systems is on the nanoscale, around 1-1000 nm.

Rate Equation:
dC/dt = k(C-C*)

You're right, to fully disclose how C is modeled I should state the formulas and constants.

In the flotation rate equation:

dC/dt = k(C - C*)

C represents the concentration of valuable metal/mineral in the flotation concentrate at any given time.

If plant data on concentrate grade (C values) over time is provided, the model uses that directly.

If no time-based C data is available, the model calculates C implicitly using the integrated rate law formula:

C = C* - (C* - C0)e-kt

Where:
C0 = initial concentration in pulp/feed
C* = equilibrium/maximum concentration (65-90% of the head grade.)
k = rate constant from Arrhenius equation
t = time.

The rate constant k is calculated using the Arrhenius equation:

k = A*exp(-Ea/RT)

Where:
A = pre-exponential factor, typically 1011 m3/g-min
Ea = activation energy, usually 50 kJ/mol
R = universal gas constant, 8.314 J/mol-K
T = temperature in Kelvin

C. Gravity
Particle Settling:
v = g*(ρp - ρf)/18*μ * d2

The variables are:
v = terminal settling velocity
g = acceleration due to gravity, 9.81 m/s2
ρp = particle density, 2500 - 4000 kg/m3
ρf = fluid density, approximately 1000 kg/m3
μ = fluid viscosity, ranging from 0.0005-0.005 Pa·s
d = particle diameter

D. Heap/CIL/CIP
Leaching:
Same as cyanidation above

Dynamic Tank Model:
dV/dt = Fin - Fout
dC/dt = (FinCin - FoutCout)/V + R - kC

You're quite right, I should disclose all parameters for the dynamic tank model equations as well. Here are the constants and ranges:

Dynamic Tank Model:

dV/dt = Fin - Fout

Fin = Inlet flow rate (m3/hr)
Range: Depends on tank size, usually 0.5-50 m3/min or 50-5000 m3/hr

Fout = Outlet flow rate
Calculated from volume and residence time (5-60 min typical)

$dC/dt = (FinCin - FoutCout)/V + R - kC$

Cin = metal concentration entering tank (g/L)
Ranges: 0.1-10 g/L

Cout = metal concentration leaving tank (g/L)
Calculated based on recovery performance

V = volume in tank (m3)
Ranges: 10-1000 m3

R = metal recovery/extraction rate (g/L-hr)
Estimated using leach kinetics rate equations

k = metal dissolution/desorption rate constant (1/hr)
Ranges: 0.001-0.1 1/hr

Carbon Contact:
Forward: k1CQ
k1 range: 0.005 - 0.015 L/g-min

Reverse: k-1Q
k-1 range: 0.0025 - 0.0075 1/min

For carbon saturation Q:

$Q = Q0 * e^{(-k3*t)}$

Q0 range: 50 - 150 mg metal/g carbon
k3 range: 0.0005 - 0.0015 1/min
t is time elapsed.
The C concentration in the dynamic tank model is calculated from:

C = C* - (C* - C0)e-kt

C0 range: Head grade +/- 20%
C* range: 70-95% of C0
k from Arrhenius equation: A=1011, Ea=30-80 kJ/mol

5. Initial Recovery Prediction comprehensive technical list of all inputs, formulas, parameters and constants
Formulas:
Comminution:
- Bond Work Index (kWh/t) = 13.048*(P80)-0.4915

Gravity Recovery Formula:
- Rg(%) = 100*(1 - e-kt)
Where:
k = specific rate constant (hr-1) derived from batch tests
Range: 0.1-1 hr-1 for free gold
Particle size dependent
t = residence time in gravity circuit (hrs)
Typical range: 0.25-1 hrs

Flotation Recovery Formula:
- Rf(%) = 100*(1 - e-kt)
Where:
k = flotation rate constant
Range: 0.02-0.5 hr-1
t = flotation cell residence time (mins)
Range: 20-60 mins

Leach Recovery Formula:
- Rl(%) = 100*(1 - e-kt)
Where:
k = rate constant from leach kinetic tests
t = residence time in leach circuit (hrs)
Range: 12-72 hrs

Carbon Adsorption Formula:
- q = k*C*t
Where:
k = rate constant (L/g/hr)

Dependent on: Particle size, pH, temp
Range: 0.01-1 L/g/hr
C = gold concentration in pulp (g/L)
t = contact time in CIL/CIP (hrs)
Range: 6-24 hrs

Overall Recovery:
- Rt = Rg + Rf + Rl - Rg*Rf - Rg*Rl - Rf*Rl + Rg*Rf*Rl

Constants:
- Gravity recovery limits = 95-98%
- Leach residence times = 6-72 hrs
- Equipment throughputs in tph
- Bond Work Index ranges by ore type = 10-18 kWh/t
- Carbon loading capacities = 25-50 g Au/t
- Reagent consumptions per tonne of ore

Parameters:
- Rate constants (k) from batch tests = 0.01-1 hr-1
- Process water requirements in m3/hr
- Energy inputs by unit operation

Let me know if you require any additional information! Metallurgical modeling is central to optimization.

6. Total Recovery Projection
- Monte Carlo simulations varying inputs 1000 times
- Returns mean, standard deviation, confidence intervals

7. Optimization Simulation
- Adjusts parameters over ranges to maximize recovery