

Symbols

Sets

Name	Domains	Description
i	*	products
j	*	stages
k	*	potential number of parallel units

Parameters

Name	Domains	Description
h		horizon time (available time hrs)
q	i	demand of product i
alpha	j	cost coefficient for batch units
beta	j	cost exponent for batch units
coeff	k	represent number of parallel units
s	i, j	size factor for product i in stage j (kg per l)
t	i, j	processing time of product i in batch j (hrs)

Variables

Name	Domains	Description
y	k, j	binary variable denoting stage existence
v	j	volume of stage j (l)
b	i	batch size of product i (kg)
tl	i	cycle time of product i (hrs)
n	j	number of units in parallel stage j
cost		total cost of batch processing units (\$)

Equations

Name	Domains	Description
vol	i, j	calculate volume of stage j
cycle	i, j	calculate cycle time of product i
time		time constraint
units	j	calculate number of processing units per stage
lim	j	limit selection to one number
obj		objective function definition

Equation Definitions

$\text{vol}_{i,j}$

$$v_j \geq \log(s_{i,j}) + b_i$$

$\forall i, j$

cycle_{*i,j*}

$$n_j + tl_i \geq \log(t_{i,j}) \quad \forall i, j$$

time

$$\sum_i (q_i \cdot \exp((tl_i - b_i))) \leq h$$

units_{*j*}

$$n_j = \sum_k (coeff_k \cdot y_{k,j}) \quad \forall j$$

lim_{*j*}

$$\sum_k y_{k,j} = 1 \quad \forall j$$

obj

$$cost \geq \sum_j (alpha_j \cdot \exp((n_j + beta_j \cdot v_j)))$$

$$v_j \geq 0 \quad \forall j$$

$$b_i \geq 0 \quad \forall i$$

$$n_j \geq 0 \quad \forall j$$

$$tl_i \geq 0 \quad \forall i$$

$$y_{k,j} \in \{0, 1\} \quad \forall k, j$$