2k Factorial Experimentation for selection of Hopper

Objective

Hopper is one of the components of material conveying system. Material is put into the hoppers and so that can be transported to the required locations using belt conveyor, screw conveyor or pneumatic conveyor or can be directed loaded in the trucks. The parameters used for the study are shape, outlet area and the height of the hopper. If it is not properly designed it may lead to retaining of the material on the surface, accumulation of the material at the outlet, resulting in low flow rate.

Controllable factors

	Type	**Outlet area**	**Height**
	(A)	(B)	(C)
Low level (-1)	Square	1 Sq.cm	10cm
High Level (+1)	Circular	3 Sq.cm	15cm

Constant factors Volume of sand = 500 cc
Size of sand grains = 100 mesh

Response : **Time for flow of 500 cc of sand in seconds**

Uncontrollable factor : Moisture content of sand

Replications –Two

Yate's algorithm is used to calculate the Effect.

	A	B	C	Run Order		Response in sec		Avg. Response	1	2	3	Divisor	Effect	Var	Effect to Std. Error
				1	2	R1	R2								
1	-1	-1	-1	7	2 (10)	47	43	45	78.5	98	188	8	23.5	8	17.925
a	1	-1	-1	1	1 (9)	33	34	33.5	19.5	90	-6	4	-1.5	0.5	-1.144
b	-1	1	-1	8	6 (14)	9	13	11	73	-14	-115	4	**-28.8**	8	**-21.930**
ab	1	1	-1	6	4 (12)	8	9	8.5	17	8	-3	4	-0.75	0.5	-0.572
c	-1	-1	1	4	3 (11)	28	35	31.5	-11.5	-59	-8	4	-2	24.5	-1.526
ac	1	-1	1	5	7 (15)	39	44	41.5	-2.5	-56	22	4	**5.5**	12.5	**4.195**
bc	-1	1	1	2	8 (16)	10	9	9.5	10	9	3	4	0.75	0.5	0.572
abc	1	1	1	3	5 (13)	7	8	7.5	-2	-12	-21	4	**-5.25**	0.5	**-4.005**
													Sp^2	6.875	
													Sp	2.622	
													Std. Error	1.311	

Significant factors

Outlet area(B), Interaction(AC) ,Interaction(ABC)

Model Equation

Y = β0+ β2(B)+ β13(AC)+ β123(ABC)+ β1(A)+ β3(C)
Y = 23.5 –14.375 B+2.75 AC− 2.625 ABC−0.75A−1C
** Though A and C are not significant, they have been taken in the model equation as interaction AC has significant value.

Conclusion

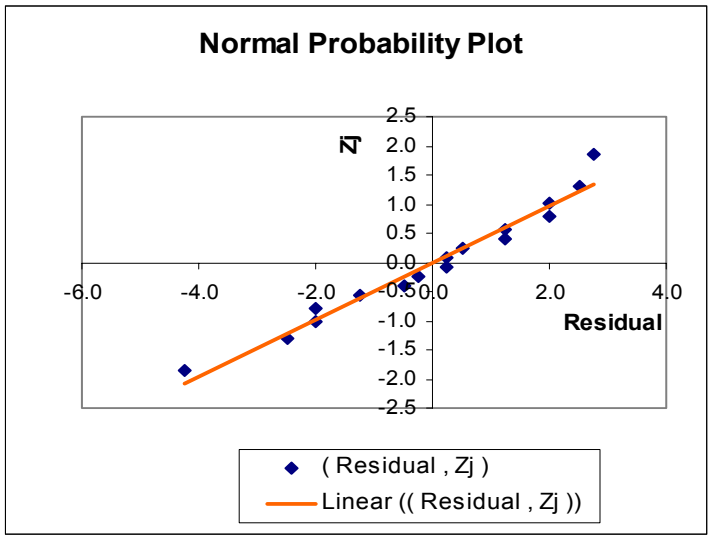
It is found that the outlet area has the maximum influence on the material flow rate. Circular c/s can be used when the height of the hopper is less.

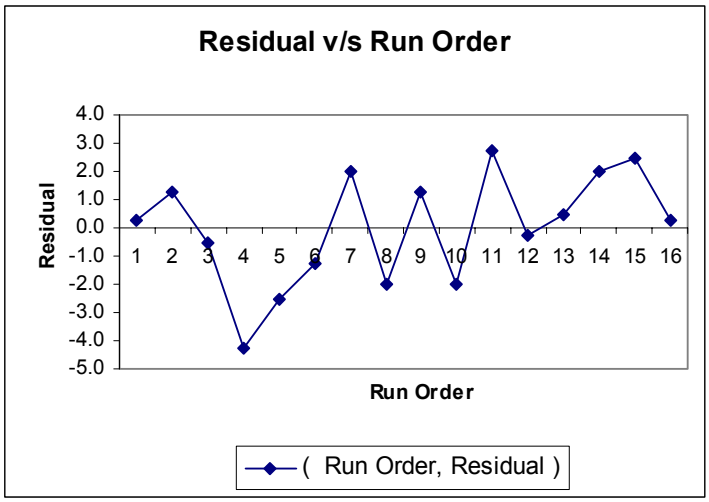
Calculation of Residuals

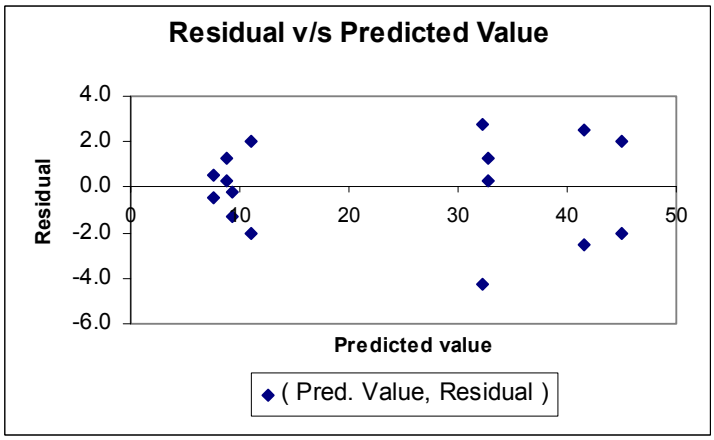
Constant	Effect	PV	Resp1	Resi 1	Resp 2	Resi 2	
β0	23.500	45.00	47	2.00	43	-2.00	1
β1	-0.750	32.75	33	0.25	34	1.25	a
β2	**-14.375**	11.00	9	-2.00	13	2.00	**b**
β12	-0.375	9.25	8	-1.25	9	-0.25	ab
β3	-1.000	32.25	28	-4.25	35	2.75	c
β13	**2.750**	41.50	39	-2.50	44	2.50	**ac**
β23	0.375	8.75	10	1.25	9	0.25	bc
β123	**-2.625**	7.50	7	-0.50	8	0.50	**abc**

PV - Predicted Value
Residual = Response – PV
β0 = Average Response
β1, β2…..= (Effect / 2)

Check for the Residual







From the above we can conclude that the residual are having normal distribution and check for the variability is satisfactory.