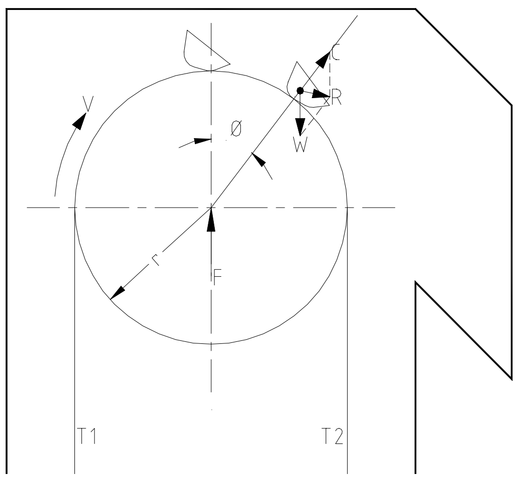
$v^2 = g \cdot r \cdot \cos\beta$

$\cos\beta$ = 1 at top dead centre.

Therefore $r = \frac{v^2}{g}$ and diameter $(d) = 2 \cdot r$



CALCULATE THROW INTO CHUTE AND CHUTE SIZE

Using the standard trajectory formula $s = u \cdot t + 0.5 \cdot a \cdot t^2$
Where s = displacement (m)
u = initial velocity (m/s)
a = acceleration (m/s^2) = gravity constant g = 9.8 m/s^2
t = time (sec)

The trajectory after the product leaves the bucket can be graphed and the chute height determined.

The horizontal component at top dead centre of the pulley where acceleration due to gravity in the horizontal direction is zero is given by $s_h = u \cdot t$ meters.

The vertical component at top dead centre where velocity in the vertical direction is zero is given by $s_v = 0.5 \cdot a \cdot t^2$ meters.

The distance of the chute from the vertical center of the head pulley must be sufficient to allow the buckets to clear the wall of the elevator on the downward leg.

The differential velocity of the inner and outer lips of the bucket must not be large, else the product at the outer lip may discharge too early when the bucket enters the centrifugal zone and hit the top to fall back to the bottom.

DETERMINE THE DRIVE ARRANGEMENT

With the head pulley size determined and the linear belt speed known, the RPM of the head pulley can be calculated.

$$RPM = \frac{V(m/s)}{2 \cdot \pi \cdot r(m)} \cdot 60$$

Usually a 4-pole motor at 1450 RPM with a reduction gearbox of suitable ratio is selected to drive the head pulley. The gearbox can be a direct drive or shaft-mounted unit depending on the available space and access.

The belt velocity using a bucket spacing of 700 mm with the removal rate of 1.7 bucket/sec x 0.7 m = 1.2 m/sec. The pulley diameter is now d = r.2 = (1.2^2 / 9.8) . 2 = 300 mm. The diameter could be made slightly larger if necessitated by the discharge throw requirements.

CALCULATE THROW INTO CHUTE AND CHUTE SIZE

Calculate the horizontal and vertical position of the product for every 0.1 seconds of flight time.

TIME (sec)	HOR. DIST. (mm)	VERT. DIST (mm)
0.1	120	50
0.2	240	195
0.3	360	440
0.4	480	780
0.5	600	1220

From the table it is noted that after 0.2 seconds of flight the product has traveled 240 mm horizontally from top dead centre and 195 mm vertically. The pulley radius is 150 mm which means the product is clear of the pulley by 90 mm. But it is not yet clear of the 270 mm radius circle scribed by the lip of the bucket (allowing for belt thickness).

This distance is reached shortly after 0.2 seconds. A satisfactory chute depth would be 600 mm, with the chute opening starting 350 mm from the vertical centre of the head pulley. This makes the bucket elevator 700 mm deep. Because of the 150 mm width of the buckets a 175 mm wide belt on 200 mm wide head pulley will be used. To provide clearance to the wall the elevator it will be 250 mm wide.

The inner lip of the bucket is at a radius of 150 mm and the outer lip at 250 mm. The inner lip travels at 1.2 m/sec as it comes around the pulley and the outer lip travels at 2 m/sec (velocity is proportional to the radius). This is a speed differential of 1.7.

Depending on the product properties this speed differential could be too great. It would be acceptable to increase the pulley diameter to 600 mm. The inner lip is now at a radius of 300 mm and the outer lip is at 400 mm. This is a differential of 1.33.

If the pulley diameter were changed the trajectory and discharge chute size should be checked.

DETERMINE THE DRIVE ARRANGEMENT

$$RPM = \frac{1.2}{2 \cdot \pi \cdot 0.3} \cdot 60 = 38$$

It will be necessary to select sprocket sizes for the motor and head pulley to produce the required rotational speed.

A gearbox can be selected to reduce from 1450 RPM input shaft speed to 38 RPM output shaft speed. Alternatively the sprocket sizes can be used to produce some of the reduction and the gearbox the remainder. Limit reduction via the sprockets to around a 3:1 ratio to not over-stress the chain.

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