Multi-Stage Process Costing

In a single-product company with two stages of production the following definitions and data are valid:

$DMC = 100000$	Direct cost of materials for unfinished products
$PC_1 = 180000$	Production cost stage 1
$PC_2 = 54000$	Production cost stage 2
$AC = 117500$	Administration cost
$SC = 18800$	Sales cost
$a = 1$	Quantity of unfinished products needed for one finished product
$xp_u = 5000$	Quantity of unfinished products produced
$xp_f = 4500$	Quantity of finished products produced
$xs = 4700$	Quantity of finished products sold
$p = 100$	Selling price of a finished product

The direct costs of materials and the production cost in stage 1 are related to manufacturing unfinished products. Thus the sum of both is the manufacturing cost of production for unfinished products:

(1) $MCOP_u = DMC + PC_1$ Manufacturing cost of production for unfinished products

$MCOP_u = 280000$

Dividing these costs by the appropriate quantity gives the cost per unit of an unfinished product:

(2) $dmc = \frac{DMC}{xp_u}$ Direct cost of materials per unit of an unfinished product

$dmc = 20$

(3) $pc_1 = \frac{PC_1}{xp_u}$ Production cost per unit of an unfinished product

$pc_1 = 36$

(4) $mc_u = dmc + pc_1$ Manufacturing cost per unit of an unfinished product

$mc_u = 56$

In stage 2 the unfinished products are processed into finished products. According to the number of unfinished products needed for a finished one, their manufacturing costs become part of the manufacturing costs of the finished products. Additionally, the processing cost in stage 2, related to finished products, must be taken into account:

(5) $pc_2 = \frac{PC_2}{xp_f}$ Production cost per unit of a finished product

$pc_2 = 12$

(6) $mc_f = a \cdot mc_u + pc_2$ Manufacturing cost per unit of a finished product

$mc_f = 68$

Dividing administration cost and sales cost by the number of goods sold yields the administration cost per unit and the sales cost per unit:

(7) $ac = \frac{AC}{xs}$ Administration cost per unit

$ac = 25$

(8) $sc = \frac{SC}{xs}$ Sales cost per unit

$sc = 4$

Adding the manufacturing cost, the administration cost and the sales cost yields the total cost:

(9) $tc = mc_f + ac + sc$ Total cost per unit

$tc = 97$

The result per unit is obtained by deducting total cost per unit from the selling price:

(10) $r = p - mc_f - ac - sc$ Result per unit

$r = 3$

In order to establish a profit-and-loss statement, cost-of-sales results accounting or total cost results accounting may be applied.

Turnover is the starting point for both methods. Since only finished products are sold, the turnover is:

(11) $S = p \cdot xs$ Turnover (sales by currency units)

$S = 470000$

In cost-of-sales results accounting the income statement of a trade enterprise is transferred to an industrial company. The result, profit or loss, of a trading company is determined by deducting from the sales the costs of goods sold and the remaining costs. The costs of goods sold of a specific product are simply the number of goods sold multiplied by the acquisition cost per unit. In an industrial company, where trading is replaced by manufacturing, accordingly the purchase price is replaced by the manufacturing cost:

(12) $MCOGS = mc_f \cdot xs$ Manufacturing cost of goods sold

$MCOGS = 319600$

The result is:

(13) $R = S - MCOGS - AC - SC$ Result according to cost-of-sales results accounting

$R = 14100$

Wheras equation (13) is valid generally, for a single-product company the MCOGS can be shown explicitly by substituting equation (12) into (13):

(14) $R = S - mc_f \cdot xs - AC - SC$

$R = 14100$

The simplest method for determining the result, however, is multiplying total cost per unit by the number of goods sold:

(15) $R = r \cdot xs$

$R = 14100$

The correctness of this procedure can be checked, if the elements of the result per unit according to (10) are multiplied by the number of goods sold.

Multiplying mc_f by xs gives MCOGS, according to (7) ac · xs is the administration cost, and according to (8) sc · xs is the sales cost. In order to achieve this result, total administration cost and total sales cost were divided by the number of goods sold. A cost accountant must be aware of marketing people trying to find out total profit or loss yielded by a specific product by multiplying the result per unit by the number of goods sold. So, before they act like that we in the cost accounting department provide the results being correct.

Now, the ideas of total cost results accounting can be derived form the basic equation of cost-of-sales results accounting.

For this it is necessary to look at the development of the stock of finished products from the beginning inventory to the ending inventory. We define:

$BI_f = 500$ Beginning inventory of finished products by units of quantity

$CA = 0$ Capitalized assets by units of quantity

So we have:

(16) $EI_f = BI_f + xp_f - xs - CA$ Ending inventory of finished products by units of quantity

$EI_f = 300$

The difference between ending inventory and beginning inventory is the change in inventory. Resolving (16) for this term yields:

(17) $CI_f = xp_f - xs - CA$ Change in inventory of finished products by units of quantity

$CI_f = -200$

Rearranging (17):

(18) $xs = xp_f - CI_f - CA$

$xs = 4700$

Substituting (18) into (14):

(19) $R = S - mc_f \cdot \left(xp_f - CI_f - CA\right) - AC - SC$

$R = 14100$

Rearranging (19):

(20) $R = S + mc_f \cdot CI_f + mc_f \cdot CA - mc_f \cdot xp_f - AC - SC$

$R = 14100$

The term $mc_f \cdot xp_f = 306000$ is not yet equal to the total manufacturing cost of production as required by the method of total cost results accounting. In fact the MCOP contain all costs which are related to manufacturing the existing products, namely the direct cost of materials, the production cost in stage 1 and the production cost in stage 2:

(21) $MCOP = DMC + PC_1 + PC_2$

$MCOP = 334000$

In fact there are MCOP for finished products and for unfinished products.The MCOP of unfinished products became part of the MCOP for finished products [see equation (6)], but only insofar as the unfinished products were actually needed. If not all unfinished products were used, the difference was put into stock, and vice versa the difference was taken from stock. In other words: The change in inventory of unfinished products has to be taken into account. In order to make this change in inventory visible, as a first step in the term $mc_f \cdot xp_f$ of equation (20) the element mc_f is replaced by the right side of equation (6):

$R = S + mc_f \cdot CI_f + mc_f \cdot CA - (a \cdot mc_u + pc_2) \cdot xp_f - AC - SC$

(22) $R = S + mc_f \cdot CI_f + mc_f \cdot CA - a \cdot mc_u \cdot xp_f - pc_2 \cdot xp_f - AC - SC$

$R = 14100$

The term $a \cdot xp_f = 4500$ now contained in equation (22) is the number of unfinished products used, since for each finished product there is a need of $a = 1$ unfinished products.

In order to introduce the unfinished products explicitly into the equation of the result, the number of unfinished goods must be traced from the beginning inventory to the ending inventory. For the beginning inventoy an arbitrary value may be assumed:

$BI_u = 100$ Beginning inventory of unfinished products by units of quantity

The ending inventory is:

(23) $EI_u = BI_u + xp_u - a \cdot xp_f$ Ending inventory of unfinished products by units of quantity

$EI_u = 600$

The difference between ending inventory and beginning inventory is, as always, the change in inventory:

(24) $CI_u = xp_u - a \cdot xp_f$ Change in inventory of unfinished products by units of quantity

$CI_u = 500$

From this follows:

(25) $a \cdot xp_f = xp_u - CI_u$

Substituting equation (25) into (22):

$R = S + mc_f \cdot CI_f + mc_f \cdot CA - mc_u \cdot (xp_u - CI_u) - pc_2 \cdot xp_f - AC - SC$

(26) $R = S + mc_u \cdot CI_u + mc_f \cdot CI_f + mc_f \cdot CA - mc_u \cdot xp_u - pc_2 \cdot xp_f - AC - SC$

$R = 14100$

This equation shows the result according to total cost results accounting: The turnover is increased by the change in inventory of unfinished products, priced at their manufacturing cost, the change in inventory of finished goods and the capitalized assets are added, both priced at their manufacturing cost, and the total is the so called performance. The manufacturing costs of goods sold and all other costs are deducted from the performance in order to obtain the result, profit or loss.

Obviously equation (26) contains a new formulation of MCOP:

(27) $MCOP = mc_u \cdot xp_u + pc_2 \cdot xp_f$

$MCOP = 334000$

Thus the total MCOP can be explained as MCOP of unfinished products, namely $mc_u \cdot xp_u = 280000$ plus additional processing costs for transforming unfinished products into finished ones, $pc_2 \cdot xp_f = 54000$.

In order to get further insights into the nature of total MCOP, pc_2 may be removed from equation (27). This can be done by rearranging equation (6):

(28) $pc_2 = mc_f - a \cdot mc_u$

$pc_2 = 12$

Substituting equation (28) into (27) and rearranging the new equation gives a new formulation of MCOP:

(29) $MCOP = mc_f \cdot xp_f + mc_u \cdot (xp_u - a \cdot xp_f)$

$MCOP = 334000$

In this view the MCOP consist of the MCOP of finished products, $mc_f \cdot xp_f = 306000$ plus the change in inventory of unfinished products, priced at its manufacturing cost, $mc_u \cdot (xp_u - a \cdot xp_f) = 28000$. In fact, the number of finished goods produced and the change in inventory of unfinished goods is the result of manufacturing. What could it be else?

For finding the result, however, it is not necessary to determine MCOP from costs per unit, as was done in equation (27) and equation (29). If total cost results accounting is applied, total costs, as they are, can be screened against the total performance, i.e. the turnover plus the change in inventory of unfinished goods plus the change in inventory of finished goods plus the capitalized assets. Once the total performance is determined, all costs as resulting from cost type accounting can be deducted without any change - a great advantage of total cost results accounting, which simplifies life in the accountancy. So we have:

(30) $TP = S + mc_u \cdot CI_u + mc_f \cdot CI_f + mc_f \cdot CA$ Total performance

$TP = 484400$

(31) $TCOP = DMC + PC_1 + PC_2 + AC + SC$ Total cost of production

The profit or loss is:

(32) $R = TP - TCOP$

$R = 14100$