



Poultry Processing: Measuring True Water Use

Converting your plant from *gpb* to *gpk*

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U.S. poultry processors slaughter approximately 9 billion broilers annually. The state of Georgia accounts for 1.4 billion (15%) of the national total, making it the country's top poultry producer. Poultry slaughter involves processing a live bird and converting it into wholesome, edible meat suitable for human consumption.

For decades, U.S. poultry slaughter plants solely produced intact whole (primary-processed) carcasses that were then sold to retailers and restaurants for further processing and sale. However, as society's demand for convenience-based food products has continued to grow, the modern poultry slaughter plant has shifted from the traditional primary-only processing model to a more complex operation that encompasses multiple further processing steps. Only a few primary-only processing plants remain in operation in the U.S. Today's modern poultry processing plant slaughters more than 200,000 birds per day and includes, on average, three additional processing operations within the broad categories of cut-up, deboning and specialty-preparation. Despite this shift towards more complexity in poultry slaughter plant operations, many aspects of facility operations still rely on the dated primary-only processing model to monitor plant efficiency. This is the case with the monitoring and tracking of **water use**.

The industry standard established decades ago for tracking water-use efficiency within poultry slaughter plants (and as a means of comparing water

use between facilities) is gallons of water used per bird slaughtered, or more simply **Gallons Per Bird (*gpb*)**. The *gpb* calculation is simple:

$$\mathbf{gpb = \frac{\text{total gallons of water used}}{\text{total number of birds slaughtered}}}$$

This traditional calculation was effective at monitoring a plant's water use over time and comparing water use among plants when the traditional primary-only processing plant model was true. However, the simplistic *gpb* calculation does not provide a true indication of today's plant water-use efficiency.

It is the goal of this publication to introduce the development of a more accurate measurement of water-use efficiency based on the bulk quantities of materials handled at each processing step at a poultry slaughter plant. This new unit of measurement is the gallons of water use per 1,000 pounds of material handled, or **Gallons Per 1,000 (*gpk*)**. The *gpk* calculation is also simple:

$$\mathbf{gpk = \frac{\text{total gallons of water used}}{\text{total 1,000 lb units of material handled}}}$$

Gallons Per 1,000 (*gpk*) has a logical advantage over *gpb* in that it takes into account the additional processing steps that U.S. poultry slaughter plants encompass today. This advantage also holds true over the alternative water-use efficiency unit of **Gallons Per Pound of Finished Product** that some plants use.

Importance of Accurate Water-Use Tracking

Georgia, like most states in the Southeast, has been subject to extended periods of drought that have resulted in a heightened awareness of water as a precious and often limited natural resource. Recognizing the importance of planning for the sustainable use of water resources, the state developed the Georgia Statewide Comprehensive Water Management Plan and the subsequent Water Conservation Implementation Plan in the mid-2000s. In 2009 Dr. Carol Couch, director of Georgia's Environmental Protection Division, was asked what the state's most challenging environmental issues in the coming decades would be. Her answer was, "WATER, WATER and WATER."

Georgia's poultry industry must be ready to make environmental regulators, elected officials and the general public aware of the efficient ways that poultry processors use water in the preparation of wholesome and safe poultry products. The *Gallons Per 1,000 (gpk)* unit of water-use measurement can be utilized to show industry efficiency today, in the future and even in the past (see *Advantages of gpk over gpb*).

The Modern Poultry Slaughter Plant

In 2009, U.S. broiler processing plants slaughtered more than 8.5 billion birds totaling a live weight of more than 47.6 billion pounds (an average live weight of 5.6 pounds per bird). These broilers were processed in more than 160 facilities located in 30 states. Each broiler slaughter plant was thus responsible for processing, on average, 52.5 million birds during the year – that's just over 1 million birds per week, or approximately 200,000 birds per day.

Each year *WATT PoultryUSA* (<http://www.wattpoultryusa-digital.com>) conducts an extensive survey of the U.S. poultry processing industry. This survey tracks the type of poultry processed (i.e., broiler, turkey), plant location (i.e., city, state) and processing operations taking place in each facility. In the survey, poultry processing is divided into four basic categories, with three of those categories being further subdivided:

1. Slaughter (i.e., live poultry processing to whole carcasses)
2. Cut-up
 - 2.1 Bulk Parts (cut-up parts packed in bulk bags, boxes, bins)

- 2.2 Prepack (cut-up parts prepacked in wrapped trays)
- 2.3 Fast-Food Cuts (cut-up parts produced under customer specifications)
3. Debone
 - 3.1 Deboning of carcass: Unspecified
 - 3.2 Deboning of "Big Birds"
 - 3.3 Deboning of "Portioned Control Birds"
 - 3.4 Deboning of "Tray-Pack Birds"
4. Specialty Preparations
 - 4.1 Detailed Portioning or Forming of Deboned Meat
 - 4.2 Cooking or Canning of Deboned Meat
 - 4.3 Mechanically Deboned Meat (MDM)
 - 4.4 Individually Quick Frozen (IQF) Product

Survey respondents may identify up to 12 separate operational processes for poultry entering their plant to produce that facility's specific product mix. To understand the diversity of today's U.S. poultry slaughter plants, and highlight the need to evaluate water use beyond the traditional *gpb* unit of measure, the 2010 *WATT PoultryUSA* survey results (<http://www.wattagnet.com/uploadedFiles/1002USplants.pdf>) for the nation's top five broiler-producing states (i.e., Georgia, Arkansas, Alabama, Mississippi and North Carolina, representing 55% of U.S. production) were analyzed.

The *WATT PoultryUSA* survey shows the top five poultry-producing states contain 85 broiler slaughter plants: Ga.-19, Ark.-19, Ala.-19, Miss.-15, and N.C.-13. Only one of the 85 total broiler plants was identified as a primary-only processor. The remaining 84 facilities listed at least one additional further processing operation. Table 1 shows the portion of these 85 total slaughter plants conducting each further processing operation. Figure 1 shows the same data as a percentage of the total number of plants. The cut-up of carcasses into parts destined for bulk packing is by far the most prevalent further processing step undertaken in broiler slaughter plants, with 70 (82%) of the 85 plants producing bulk parts. The remaining 10 further processing operations are used by 30 (35%) or fewer of the 85 total plants.

The survey also shows that broiler processing plants range from one primary-only processing facility to a slaughter plant that lists seven further processing steps. Figure 2 shows the number and percentage of the operational processes conducted at the 85 plants. The survey results show that the average

broiler slaughter plant in the top five producing states conducts four operational processes (primary plus three additional further processing steps). Georgia alone highlights the diversity of modern broiler slaughter plants. The 19 Georgia broiler slaughter plants in the survey list 15 different combinations of primary and further operational processes.

Table 1. Number of broiler slaughter plants conducting various operational processes for facilities in Ga., Ark., Ala., Miss. and N.C. (85 total plants)

Operational Category	Operational Processes	Number of Plants
1. Slaughter		85
	1.1. Slaughter Only	1
2. Cut-up	2.1. Bulk Parts	70
	2.2. Prepack	16
	2.3. Fast-Food Cuts	26
3. Debone	3.1. DB Unspecified	23
	3.2. DB "Big Birds"	30
	3.3. DB "Portion Control Birds"	16
	3.4. DB "Tray-Pack" Birds	4
4. Specialty-Prep	4.1. Portioned/Formed	24
	4.2. Cooking/Canning	12
	4.3. Mechanically Deboned Meat (MDM)	13
	4.4. Individually Quick Frozen (IQF)	26

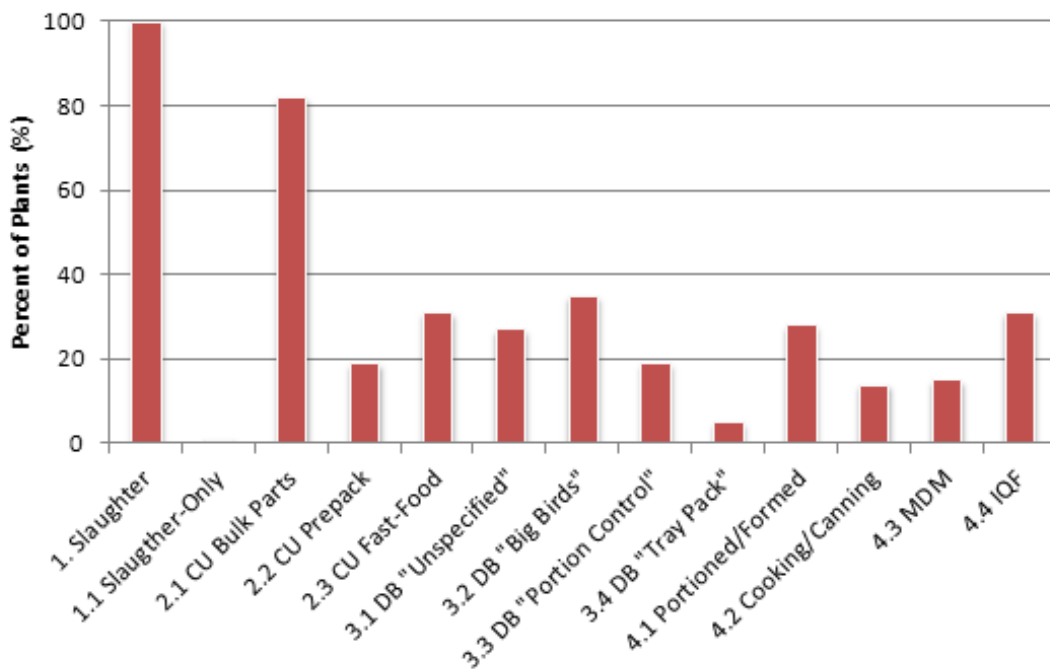


Figure 1. Percentage of broiler slaughter plants conducting various operational processes for facilities in Ga., Ark., Ala., Miss. and N.C. (85 total plants)

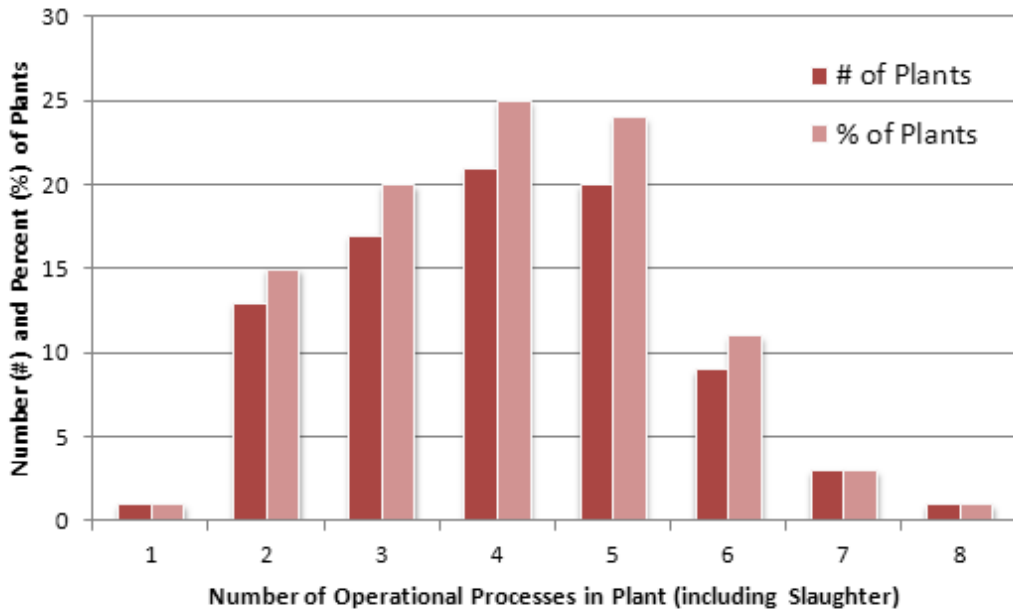


Figure 2. Number (#) and percentage (%) of operational processes taking place in broiler slaughter plants in Ga., Ark., Ala., Miss. and N.C. (85 total plants)

Converting Your Plant to Gallons Per 1,000 (gpk)

Because of the complexity of the combinations of processing operations that take place in the typical poultry slaughter plant today, a new measure of water use is needed. The new measure should effectively evaluate the efficiency of water use in a plant over time and enable better water-use comparisons between plants. This can be accomplished by converting poultry processing plants to the *Gallons Per 1,000 (gpk)* unit of water-use measurement.

The *gpk* measurement simply replaces the denominator in the *gpb* formula with a more accurate measure of the level of production in a poultry slaughter plant (i.e., weight of material handled versus number of birds processed):

$$gpb = \frac{\text{total gallons of water used}}{\text{total number of birds slaughtered}}$$

Replaced by

$$gpk = \frac{\text{total gallons of water used}}{\text{total 1,000 lb units of material handled}}$$

Advantages of *gpk* over *gpb*

One inherent advantage of *gpk* is the ease of conversion from *gpb*. Using *gpk* does not require more extensive evaluation of water use (e.g., installing additional water meters, more extensive monitoring of wastewater flows) because the water flow information in the numerator portion of both the *gpb* and *gpk* formulas does not change (i.e., total gallons of water used). This is because *gpk* focuses on material handling, not the specifics of water use. The difference between the two formulas is the denominator, in which the *gpk* formula's total 1,000 lb units of material handled replaces the *gpb* formula's total number of birds processed.

Also, new data collection is most likely not needed since most poultry processing plants already accurately track material handling weights through the plant on production data sheets. This production information merely has to be transcribed into the provided worksheet. In addition, because this data often already exists, processing plant staff can go back into historical plant records and produce *gpk* values for the plant in the past. This can provide a more accurate account of water use through operational changes (e.g., addition of new further processing steps) that have taken place in the past.

Comparison of *gpk* and *gpb*

Table 2 provides an illustration of the advantage of *gpk* over *gpb* for accurately depicting true water-use efficiency. Table 2 compares four fictional broiler processing plants that each slaughter 1 million birds per week at an average live weight of 5 pounds per bird (i.e., 5,000,000 pounds live weight per week) and have the same 70 percent yield.

One plant (A) is a primary-only processing facility that uses 5 million gallons (MG) of water per week producing only whole carcasses. Plant B cuts up 100 percent of the carcasses it produces into parts that are prepacked in trays, shrink-wrapped, weighed and labeled in the plant and shipped to a single large retail customer. The added processing cut-up operation in Plant B causes the facility to use 7 MG of water per week. Plant C separates 100 percent of its carcasses into front and back halves. The back halves are placed in bulk containers for export, while the front halves are cut-up into pieces for a fast-food restaurant chain. The two additional further processing operations (i.e., bulk pack and fast-food cut-up) in Plant C results in the use of 8 MG of water per week. Finally, Plant D also separates 100 percent of its carcasses into front and back halves. The back halves are placed in bulk containers for export, while the front halves go on to deboning. Plant D's front halves are deboned and the resulting breast meat is sent on to another processing operation where specific portions are prepared and then individually quick frozen (IQF).

The deboned cages from the front halves are sent on to a mechanical deboning system for MDM processing. The addition of five further processing operations (i.e., bulk parts, deboning, portioning, IQF and MDM) causes Plant D to use 9 MG of water per week.

Table 2 shows that using the traditional *gpb* calculation results in the misconception that Plant A, at 5.0 *gpb*, is the most efficient water user, while Plant D, at 9.0 *gpb*, is the least efficient. However a logical review of the plant descriptions above reveals that this is a mistaken conclusion. Table 2 also shows that the *gpk* calculation provides a much clearer picture of water-use efficiency. Plant A, which is a primary-only processing plant, utilizes 1,000 gallons of water per 1,000 pounds of material handled (i.e., 1,000 *gpk*). Plants B and C vary in the further processing operations they perform but handle the same volume of material, resulting in an equal water use of 824 *gpk*, which is approximately 18 percent less than Plant A. Finally, *gpk* shows that Plant D is the most efficient facility of all, utilizing 743 *gpk*, or 25% less than Plant A.

Figure 3 graphically compares the *gpk* and *gpb* values for each plant in the example and illustrates how *gpb* can project the misconception of water efficiency when only the number of birds processed in a slaughter plant is taken into account.

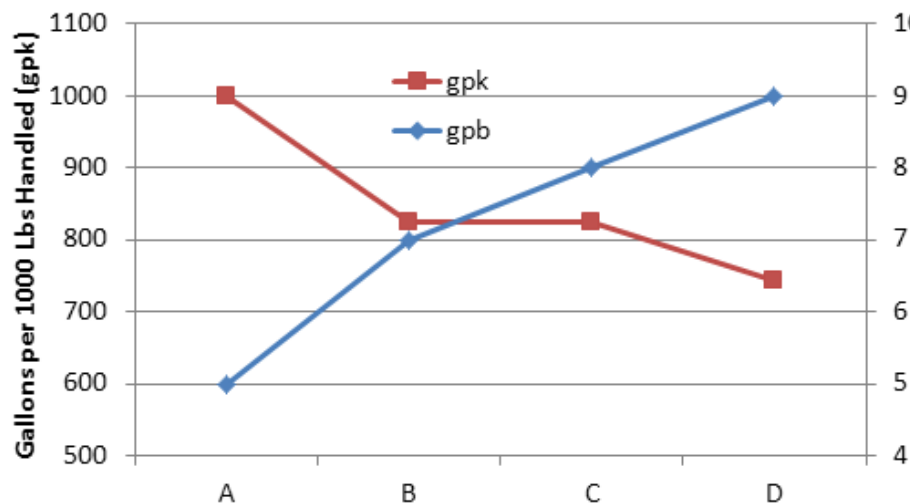


Figure 3. Comparison of gallons per bird (*gpb*) versus gallons per 1,000 pounds handled (*gpk*) units of water used for four fictional broiler slaughter plants, each processing 1 million chickens per week

Table 2. Comparison of gallons per bird (**gpb**) versus gallons per 1,000 pounds handled (**gpk**) units of water used for four fictional broiler slaughter plants, each processing 1 million chickens per week

Operational Category		Operational Processes		1,000 lbs. of Material Handled*			
				A	B	C	D
Common Plant Scenario		Individual Plant Processes					
<ul style="list-style-type: none"> • 1,000,000 birds slaughtered per week • 5.0 lbs. average live weight • 5,000,000 lbs. live weight per week • 70% yield 		<ul style="list-style-type: none"> • A: Slaughter-only • B: Slaughter, Prepack • C: Slaughter, Bulk Parts, Fast-food Cuts • D: Slaughter, Bulk Parts, Deboning, Portioning, IQF, MDM 					
1. Slaughter	Slaughter	5,000	5,000	5,000	5,000		
2. Cut-up							
	2.1. Bulk Parts			1,400	1,400		
	2.2. Prepack		3,500	2,100			
3. Debone							
	3.1. Unspecified						2,100
	3.2. Big Birds						
	3.3. Portion Control						
4. Specialty-Prep							
	4.1. Portioned/Formed						1,500
	4.2. Cooking/Canning						
	4.3. MDM						600
	4.4. IQF						1,500
Total 1,000 lbs. =		5,000	8,500	8,500	12,100		
Total Water Used =		5,000,000	7,000,000	8,000,000	9,000,000		
Gallons Per 1000 (gpk) =		1,000	824	824	743		
Birds Processed =		1,000,000	1,000,000	1,000,000	1,000,000		
Gallons Per Bird (gpb) =		5.0	7.0	8.0	9.0		

* All total material handled weights divided by 1000 and entered into table

Converting to Gallons per 1,000 Pounds Handled (gpk)

Converting your plant to *gpk* is not difficult and can be accomplished in just five steps:

1. Develop a simple schematic diagram of your plant that identifies major processing operations that utilize a significant amount of water.
2. Identify transition points between processing operations where weights of material handled are currently documented or could be documented.
3. Implement comprehensive data collection of weights of material handled at identified points.

4. Enter data in the provided worksheet or your own worksheet or computer-based spreadsheet.
5. Calculate *gpk* and track trends.

This publication contains a worksheet that can be copied and used by your plant or used as a template to develop your own paper or computer-based data-sheet to calculate *gpk* at your facility. The worksheet is simple and easy to follow. The total weight of material handled per week at each processing operation transition point is divided by 1,000 and entered into the appropriate cell. The 1,000-pound units for each operation are then totaled at the bottom of that column. The total water use in gallons for the week is entered and the *gpk* equation is applied.

Gallons Per 1,000 (GPK) Worksheet

				Week 1	Week 2	Week 3	Week 4	Month
1 Slaughter	Total Live Wt		lbs./1,000 =					
2 Cut-Up Operations								
2.1 Bulk Parts	Total Wt		lbs./1,000 =					
2.2 Prepack	Total Wt		lbs./1,000 =					
2.3 Fast-Food Cuts	Total Wt		lbs./1,000 =					
2.4	Total Wt		lbs./1,000 =					
2.5	Total Wt		lbs./1,000 =					
3 Deboning Operations								
3.1 Unspecified	Total Wt		lbs./1,000 =					
3.2 Big Birds	Total Wt		lbs./1,000 =					
3.3 Portion Control	Total Wt		lbs./1,000 =					
3.4 Tray-Pack	Total Wt		lbs./1,000 =					
3.5	Total Wt		lbs./1,000 =					
4 Specialty-Prep Operations								
4.1 Portioning / Forming	Total Wt		lbs./1,000 =					
4.2 Cooking / Canning	Total Wt		lbs./1,000 =					
4.3 MDM	Total Wt		lbs./1,000 =					
4.4 IQF	Total Wt		lbs./1,000 =					
4.5	Total Wt		lbs./1,000 =					
Total 1,000 lb. Units =								

Monthly Summary					
	Week 1	Week 2	Week 3	Week 4	Month
Total Water Use (gallons) =					
	divided by	divided by	divided by	divided by	divided by
Total 1,000 lb. Units =					
GPK =					



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