## ACCURATE COMPILATION OF BRIX, APPARENT SPECIFIC GRAVITY, APPARENT DENSITY, WEIGHT, AND POUNDS SOLIDS OF SUCROSE SOLUTIONS

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Abstract. On the basis of 2 official tables of Brix and density data, new tables of "Brix and pounds solids were prepared by the author by using computerized techniques. Extension of such techniques to retain the numbers at the best available accuracy is illustrated. A table for some selected "Brix values is presented.

An application of the table to investigate the effect of one tenth of one °Brix measurement errors revealed that the variation of cost of solids would amount to  $\pm$  5.3 million dollars for the citrus juices sold in 1981-82 season. In view of the importance of °Brix measurements, the most accurate and reliable instrument should be used to ensure the correctness of °Brix measurement in citrus processing plants.

More than a hundred million boxes of citrus fruits were used by the processors annually in the last 15 yr. Citrus fruits used for processing are sold in 2 ways; pounds-solids or pounds of juice per box. Both require the information on pounds solids contained in the fruits. Tables of °Brix and pounds solids have been prepared by several authors (1, 2, 4). The accuracy for those available publications are more than sufficient for technical as well as practical purposes. However, for accurate determination of total solids in several million gallons, slight discrepancies will be found dependent upon which table is used. Such discrepancies are resultant mostly from truncating the calculated numbers to 3 or 4 decimals for ordinary use in practice. A few minor conversion errors have also been found in tables prepared manually.

This paper presents a new table for pounds solids of sucrose up to 5 decimals for some selected °Brix values. Computerized calculations and print-outs were used to eliminate the human errors. This is an illustration of the method used by the author in a recent publication of new Brixpounds solids tables (2).

## **Materials and Methods**

<sup>o</sup>Brix, apparent specific gravity, and apparent density in g/liter were taken from 2 official tables adopted by the Florida citrus industry: Table 114 (5) and Table 1 (6).

The density data for each correspondent °Brix was used to convert to other units or other derived quantities. The data for 12°Brix will be arbitrarily selected to illustrate the calculations.

Denote the °Brix (or percent solids by weight) by B and apparent density (or weight per liter in air at 20°C) by D. Then solids weight, denoted by W, is equal to

$$W = (B x D)/100$$

For B = 12°Brix and D = 1045.41 g/liter then W = 12100

x 1045.41 = 125.449 g/liter.

The apparent density expressed in pounds per U.S. gallon (1 g/liter = 1/119.827 lb./gal) in air at 20°C, denoted by D<sub>1</sub>, was calculated by

Proc. Fla. State Hort. Soc. 96: 1983.

 $\begin{array}{l} D_1 = D/119.827 \ \text{lb./gal.} \\ \text{For B} = 12^\circ \text{Brix and D} = 1045.41 \ \text{g/liter then} \\ D_1 = 1045.41/119.827 \\ = 8.72432 \ \text{lb./gal.} \\ \text{The solids weight, denoted by W_1, is equal to} \\ W_1 = (B \ge D_1)/100 \\ \text{For B} = 12^\circ \text{Brix, and D}_1 = 8.72432 \ \text{lb./gal. then} \\ W_1 = \frac{12}{100} \ge 8.72432 \\ = 1.04692 \ \text{lb./gal.} \end{array}$ 

The apparent density expressed in pounds per cubic feet (1 g/liter = 0.062428 lb./ft<sup>3</sup>) in air at 20°C, denoted by D<sub>2</sub>, was calculated by

$$D_2 = D \ge 0.062428$$
  
= 65.2628 lb./ft<sup>3</sup>

The solids weight, denoted by W<sub>2</sub>, is equal to

$$W_2 = (B \times D_2)/100.$$

For  $B = 12^{\circ}Brix$  and  $D_2 = 65.2628 \text{ lb./ft}^3$  then

$$W_2 = \underbrace{12 \times 65.2628}_{100}$$
  
= 7.83154 lb./ft<sup>3</sup>.

A computer program was written to carry out the computation for °Brix varying from 0 to 80 °Brix at 0.1°Brix intervals. The corresponding density data were taken from the official tables. The derived data were printed out from the computer without transcription so that human errors were avoided. Only selected ranges of °Brix are shown.

## **Results and Discussion**

Table 1 shows the results of computation. To use the table, find the Brix value that corresponds to the actual measurement, then trace the line to the right to read the number under the desired heading in the top line of the table. The figure so obtained will show the computed number. For example, 41.8°Brix concentrate will have 4.13266 lb. solids/gal in air.

For technical or practical purposes, retention of 6 significant digits is not necessary. Four to 5 digits retention have been reported in the literature (1, 2). However, for large quantity calculation, the best available accuracy would be desirable.

For example, a plant has packed one million gallons of reconstituted juices at 11.9°Brix instead of required 11.8 °Brix. How much additional juice cost will be required at the solids cost of \$1.22 per pound?

From Table 1, we find solids weight 1.03778 lb./gal at 11.9°Brix and 1.02864 lb./gal at 11.8°Brix. The difference between the two is 0.00914 lb./gal. For one million gallons, the additional cost will be

Additional cost = 
$$0.00914 \ge 1,000,000 \ge 1.22$$
  
=  $\$11,150.80$ .

This example illustrates the importance of tight quality control for process operations.

The effect of °Brix measurement errors varies with the level of solids content. Errors at the lower °Brix level will have greater effect than that of the higher °Brix level. For

Table 1. Table of Brix, apparent s	specific gravity,	weight, and solids	s weight of sucrose s	olutions.
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6.0         1.02560         1002.00         41.948         8.3484         0.5114         63.705         5.3255           6.0         1.02773         1074.845         97.778         8.35255         0.56686         63.771         4.4785           7.5         1.02576         1028.85         77.014         8.4667         0.67130         64.3589         3.4705           8.0         1.03189         1028.88         8.23104         8.4867         0.67130         64.3589         3.4705           8.0         1.03591         1035.39         91.0428         8.62595         0.73478         64.5118         5.6471           9.3         1.03592         1035.39         91.038         8.62595         0.73478         64.5118         5.6471           9.4         1.03755         108.441         97.253         8.63292         0.2102         64.444         6.1385           9.5         1.03561         106.547         9.4457         0.8459         0.4416         6.1385           9.4         1.03755         106.457         104.257         8.4519         0.8459         64.4118         6.4509           9.5         1.03796         105.45         9.46477         0.4106         6.3589	°Brix or % by wt. sucrose	Apparent specific gravity 20/20°C	Wt./liter in air at 20°C (g)	Sucrose/liter in air (g)	Wt./gal in air at 20°C (lb.)	Sucrose/gal in air (lb.)	Wt./ft³ in air at 20°C (lb.)	Sucrose/ft <sup>3</sup> in air (lb.)
1.65 $1.26271$ $102.21$ $66.485$ $8.35972$ $0.55482$ $0.63500$ $4.195$ $7.0$ $1.02773$ $102.848$ $71.784$ $8.55857$ $0.68691$ $64.2309$ $5.1385$ $8.5$ $1.03500$ $102.977$ $8.2301$ $8.38657$ $0.68691$ $64.2309$ $5.1385$ $9.0$ $1.03500$ $102.977$ $8.2001$ $0.71386$ $64.4802$ $3.0056$ $9.2$ $1.035190$ $108.297$ $9.21978$ $8.62011$ $0.71386$ $64.4802$ $64.5306$ $6.0144$ $9.4$ $1.03756$ $0.044130$ $97.238$ $8.64112$ $0.82266$ $64.5306$ $6.0144$ $9.4$ $1.037567$ $108.544$ $9.778$ $8.64112$ $0.82265$ $64.5606$ $62.2365$ $9.7$ $1.038270$ $108.544$ $9.3228$ $8.64112$ $0.82265$ $64.5606$ $62.2365$ $9.7$ $1.038270$ $108.547$ $0.81737$ $8.64819$ $64.5760$ $64.5760$ <td< td=""><td>60</td><td>1 02369</td><td>1020.80</td><td>61.248</td><td>8.51894</td><td>0.51114</td><td>63.7265</td><td>3.8236</td></td<>	60	1 02369	1020.80	61.248	8.51894	0.51114	63.7265	3.8236
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	6.5	1.02571	1022.81	66.483	8.53572	0.55482	63.8520	4.1504
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	7.0	1.02773	1024.83	71.738	8.55258	0.59868	63.9781	4.4785
8.0         1.03180         1028.84         2.5310         2.63250         0.7310         0.63350         0.43350           9.1         1.26501         1002.57         22.957         8.62593         0.74478         64.4118         8.4705           9.2         1.03572         1012.57         9.5.01         8.62593         0.74478         64.4517         8.64118           9.4         1.03755         1018.72         9.5.01         8.62597         0.74478         64.4514         8.64112           9.4         1.03755         1018.54         9.9402         8.64112         0.84265         64.4444         6.1384           9.5         1.03587         1008.647         110.4574         8.64127         0.84265         64.4444         6.43386           9.3         1.035961         1008.647         110.4280         8.65139         0.85649         64.4344         6.43381           10.0         1.04644         1037.02         110.1727         8.45139         0.85649         64.4344         6.47494           10.3         1.04445         1039.39         110.727         8.45139         0.85649         64.4346         6.47494           10.4         1.044169         1039.39         110.7277	7.5	1.02976	1026.85	77.014	8.56944	0.64271	64.1042	4.8078
8.0         1.03300         1.001.09         02.967         8.00051         0.77885         64.4862         5.8706           9.1         1.03503         1.03572         1.03579         9.1.01         64.5118         5.8706           9.2         1.03572         1.03579         9.5.109         8.62735         0.73972         64.5574         5.876           9.3         1.03715         1.034.09         86.131         8.62735         0.73972         64.5574         5.876           9.4         1.03716         1.035.07         9.8328         8.8770         0.82056         64.6404         6.2305           9.7         1.03877         1.035.84         1.00.477         8.64431         0.82056         64.6404         6.2305           9.7         1.03877         1.035.20         1.03.270         8.64431         0.85049         64.7454         6.4470           10.1         1.04046         1.03.709         8.64171         0.83852         64.7440         64.7450         6.5417           10.2         1.04046         1.03.707         1.01.14         8.64774         0.84852         64.8464         6.7440           10.4         1.04421         1.03.777         1.01.14         8.64774	8.0	1.03180	1028.88	82.310	8.08037	0.06091	64 3589	5.4705
91         1.05031         10913.58         0.94.058         8.662353         0.75478         0.6118         5.5764           9.3         1.035713         1034.20         96.181         8.66077         0.80266         64.5638         6.044           9.4         1.03757         1034.61         91.233         8.66177         0.80266         64.5638         6.044           9.4         1.03757         1034.64         99.462         8.64112         0.82055         64.644         6.0384           9.5         1.03857         1005.44         99.402         8.64112         0.82055         64.6404         6.2375           9.8         1.03850         1006.25         101.544         8.64112         0.82055         64.6401         6.3384           10.1         1.04044         1097.50         104.77         8.65311         0.87449         64.7600         6.64713           10.2         1.04046         1057.51         105.846         0.87549         64.5227         6.816           10.4         1044252         1035.57         106.148         6.6491         6.62494         6.8204         0.80256         64.5968         6.8746         6.8166           10.4         104252         1035.57	8.5	1.03385	1030.93	87.029 09.067	8 62051	0.77585	64.4862	5.8038
9.2         1.08792         1053.79         95.109         8.62735         0.73972         64.5374         5.5374           9.3         1.09715         1034.61         97.253         8.63420         0.81.62         64.586         6.0044           9.4         1.03755         1035.63         100.477         8.64412         0.82055         64.646         6.2334           9.4         1.03797         1035.63         100.477         8.64454         0.83862         64.6660         6.2756           9.8         1.03520         1035.85         100.477         8.64139         0.83864         64.7172         6.6378           9.9         1.03501         1002.607         8.66173         0.88549         64.7769         6.6517           10.2         1.04066         1007.91         105.867         8.66173         0.88520         64.7466         6.6719           10.3         1.04167         100.12         8.66173         0.88252         64.8648         6.7465           10.4         1.04169         1038.74         1068.02         8.66173         0.88252         64.5745         6.5476           10.3         1.04167         103.874         1068.02         8.66864         0.99161         6	9.0	1.03590	1033 38	94.038	8.62393	0.78478	64.5118	5.8706
9.3         1.63713         1054.20         96.181         8.65077         0.80266         64.5539         6.0714           9.4         1.03755         1034.61         97.252         64.6412         0.82055         64.6404         6.0314           9.4         1.03755         1035.01         99.402         6.64112         0.82055         64.6404         6.2375           9.4         1.05870         1035.62         101.554         8.64139         0.84750         64.6916         6.3756           9.4         1.05870         1035.62         101.554         8.64139         0.84760         64.6916         6.5476           9.3         1.05870         103661         103.677         8.66381         0.87449         64.7690         6.5417           10.1         1.04046         107.50         101.787         8.66324         0.89222         64.8206         6.6746           10.3         1.04127         1085.83         106.948         8.66524         0.89225         64.8206         6.7466           10.4         1.04232         1039.77         110.194         8.67599         0.91616         64.8263         6.7466           10.4         1.04335         100.401         112.463         8.	9.2	1.03672	1033.79	95.109	8.62735	0.79372	64.5374	5.9374
9.4         1.03755         1034.61         97.253         R.63430         0.8112         6.7.369         D.103           9.5         1.03766         1035.85         100.477         8.64444         0.88125         64.6064         6.2395           9.7         1.038270         1035.85         100.477         8.64454         0.88425         64.6064         6.2395           9.9         1.03961         1036.67         102.250         8.65133         0.86449         64.7122         6.4471           10.0         1.04068         1037.01         103.797         8.64131         0.85449         64.7124         6.4476           10.1         1.040468         1037.01         105.867         8.61731         0.85429         64.7846         6.6765           10.4         1.04169         1038.74         108.822         8.60854         0.90144         64.8464         67460           10.5         1.04220         1039.59         111.279         8.62822         0.94784         64.9767         7.0466           10.9         1.04357         1040.82         113.449         8.68622         0.94780         64.9864         64.9961         7.9464           10.9         1.04357         1040.82         <	9.3	1.03713	1034.20	96.181	8.63077	0.80266	64.5630	6.0044
9.5.         1.07766         1085.08         96.232         8.05770         1.05820         0.1211         0.1211           9.7         1.03820         1036.26         101.554         8.0477         0.54144         0.583832         64.6566         6.2726           9.9         1.03920         1036.26         101.554         8.04797         0.84750         64.6516         6.3399           9.0         1.04064         1037.00         10.3770         8.05139         0.85449         64.7122         6.4070           10.1         1.04044         1007.50         10.1777         8.05481         0.85449         64.7343         6.7372           10.3         1.04047         1033.3         106.948         8.05524         0.82489         6.48763         6.48763           10.4         104169         1038.77         10.1414         8.05254         0.82864         6.48763         6.44864         6.67400           10.5         1.04210         1035.16         100.112         8.05224         0.93184         64.48764         6.4722         6.42883         6.67403           10.6         1.04223         1039.97         110.1278         8.05224         0.9371         64.99763         7.1649	9.4	1.03755	1034.61	97.253	8.63420	0.81162	64.5886	0.0713
9.0         1.03837         103343         20.472         5.44444         0.38322         74.660         6.275           9.1         1.03961         1036.67         102.630         8.61339         0.86649         64.712         6.40016           10.0         1.04044         1037.50         104.737         8.63831         0.87494         64.7016         64.7141           10.1         1.04044         1037.50         104.737         8.63831         0.87494         64.7000         6.5414           10.2         1.04044         1037.50         104.737         8.63846         0.90154         64.7484         6.6766           10.4         1.04167         1038.74         108.229         6.6766         6.6766           10.5         1.04252         1039.57         110.194         8.67599         0.91048         64.8924         6.64984         6.7494           10.5         1.04252         1039.57         110.194         8.67599         0.91048         64.8924         6.64984         6.64984         6.64984         6.64984         6.61494         7.1592           10.7         1.04263         10404.9         112.3435         8.68945         0.95744         6.63019         7.1592	9.5	1.03796	1035.03	98.328	8.63770	0.82058	04.0148	6 2055
3.5         1.03820         103820         101254         E.84797         0.84763         64.6016         6.3393           9.9         1.03861         1036,067         102,308         6.5139         0.85649         64.7172         6.64070           10.0         1.04064         1037,09         105,709         8.65139         0.85749         64.7172         6.64070           10.1         1.04044         1037,50         104,777         8.65131         0.87449         64.7434         6.67460           10.4         1.04064         1037,91         106,807         8.66174         0.82849         6.6766           10.4         1.04166         1037,91         106,807         8.66174         0.91054         64.8464         64763           10.5         1.04210         1039,16         109,112         8.67259         0.91941         64.8483         6.6769           10.6         1.04223         1099,99         111,273         8.67909         0.328471         65.019         7.1084           10.9         1.04448         104247         116,713         8.69464         0.94678         64.9763         7.2284           11.1         1.04460         10414,25         116,713         8.69464	9.6	1.03837	1035.44	99.402	8.64454	0.82955	64 6660	6.2726
3.9         1.03667         1.02.830         8.65189         0.86549         6.4.7172         6.4070           10.0         1.04064         1.057.00         10.4.787         8.65881         0.87449         6.4.7346         6.64291           10.1         1.04064         1.057.50         10.4.787         8.65881         0.87449         6.4.7346         6.60291           10.3         1.04177         103.834         108.479         8.60865         0.05154         6.84464         6.7440           10.5         1.04252         1039.977         110.194         8.672579         0.91068         6.48924         6.48924         6.49845         6.49746           10.6         1.044252         1039.977         110.194         8.672579         0.91068         6.48924         6.49946         6.49946         6.49946         6.49946         6.49946         6.49946         6.49946         6.49947         6.30281         7.2181           11.4         1.04453         104.635         114.533         8.69945         0.059492         6.5.0917         7.2381           11.4         1.04460         101.65         115.623         8.69957         0.998919         6.5.1616         7.2481           11.4         1.04460	9.7	1.03879	1035.85	101 554	8.64797	0.84750	64.6916	6.3398
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	9.0 Q Q	1.03920	1036.67	102.630	8.65139	0.85649	64.7172	6.4070
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	10.0	1.04003	1037.09	103.709	8.65489	0.86549	64.7434	6.4743
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	10.1	1.04044	1037.50	104.787	8.65831	0.87449	64.7690	6.5417
	10.2	1.04086	1037.91	105.867	8.66173	0.88350	64.7946	6.6091 6.6767
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	10.3	1.04127	1038.33	106.948	8.00524	0.89252	04.8208	6 7440
	10.4	1.04169	1038.74	108.029	8 67917	0.91058	64 8797	68116
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	10.5	1.04210	1039.10	110.194	8.67559	0.91961	64.8983	6.8792
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	10.5	1.04293	1039.99	111.279	8.67909	0.92866	64.9245	6.9469
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	10.8	1.04335	1040.40	112.363	8.68252	0.93771	64.9501	7.0146
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	10.9	1.04377	1040.82	113.449	8.68602	0.94678	64.9763	7.0824
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	11.0	1.04418	1041.23	114.535	8.68944	0.95584	65.0019	7.1502
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11.1	1.04460	1041.65	115.523	8.09295	0.90492	05.0281	7.2181
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11.2	1.04502	1042.07	110.712	8.69987	0.97400	65 0799	7 3540
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11.5	1.04585	1042.48	118.891	8.70337	0.99219	65.1061	7.4221
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	11.5	1.04627	1043.32	119.982	8.70688	1.00129	65.1324	7.4902
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	11.6	1.04669	1043.73	121.073	8.71031	1.01040	65.1580	7.5593
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	11.7	1.04711	1044.15	122.165	8.71381	1.01952	65.1842	7.6266
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11.8	1.04753	1044.57	123.259	8.71732	1.02864	65.2104 65.9266	7.0948
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	11.9	1.04795	1044.99	124.354	8.72082	1.05778	65 2628	7.7054
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	12.0	1.04857	1045.41	120.445	8 74177	1.09272	65.3933	8.1742
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	13.0	1.05259	1049.61	136.449	8.75937	1.13872	65.5250	8.5183
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	13.5	1.05470	1051.72	141.982	8.77699	1.18489	65.6568	8.8637
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	14.0	1.05683	1053.85	147.539	8.79476	1.23127	65.7897	9.2106
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	14.5	1.05897	1055.98	153.117	8.81254	1.27782	65.9227 66.0FF6	9.5588
	15.0	1.06111	1058.11	158.710	8.83031	1.02400	00.0000	9,9084
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	38.0	1.00042	1002.41	449 787	9 79497	8 69599	79 7430	27.6423
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	41.7	1.18754	1184.18	493.803	9.88241	4.12096	73.9259	30.8271
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	41.8	1.18806	1184.70	495.204	9.88675	4.13266	73.9584	30.9146
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	41.9	1.18858	1185.22	496.607	9.89109	4.14437	73.9909	31.0022
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	42.0	1.18910	1185.74	498.010	9.89543	4.15608	74.0233	31.0898
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	43.2	1.19539	1192.01	514,948	9.94770	4.29745	74.4148	32.14/2
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	44.6	1.20220	1198,80	534 997	10.0043	4.46417	74.8755	33.3945
44.81.203851200.45537.80210.01824.4881574.941733.573944.91.204381200.98539.24010.02264.5001574.974733.663645.01.204911201.51540.67910.02704.5121775.007833.753546.01.210261206.84555.14610.07154.6329075.340634.656747.01.215641212.21569.73910.16134.7546875.675835.567648.01.221061217.61584.45210.16144.8774776.012936.486249.01.226521223.06599.29910.26695.0013776.353237.413050.01.232021228.54614.27010.25265.1263176.695338.347650.11.232021228.54614.27010.25725.1388676.798238.629550.31.233131229.64617.27910.26185.1514276.763938.535550.41.234231230.74620.29310.27105.1765776.82638.723651.01.234781231.30621.80610.27565.1892076.867638.818151.01.237561234.06629.37010.28645.433977.51140.719652.01.248741236.83636.67710.32185.3157377.212839.764652.01.248741245.21659.96110.39175.5076277.735941.200153.51.24593 </td <td>44.7</td> <td>1.20332</td> <td>1199.92</td> <td>536.364</td> <td>10.0138</td> <td>4.47615</td> <td>74.9086</td> <td>33.4841</td>	44.7	1.20332	1199.92	536.364	10.0138	4.47615	74.9086	33.4841
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	44.8	1.20385	1200.45	537.802	10.0182	4.48815	74.9417	<b>33.</b> 5739
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	44.9	1.20438	1200.98	539.240	10.0226	4.50015	74.9747	33.6636
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	45.0	1.20491	1201.51	540.679	10.0270	4.51217	75.0078	33.7535
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	46.0	1.21026	1206.84	555.140	10.0715	4.03290	75.3400	34.0307 85 5676
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	47.0	1.21504	1212.21	509.759	10.1105	4 87747	76.0199	36 4862
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	49.0	1.22100	1217.01	599.299	10.2069	5.00137	76.3532	37.4130
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	50.0	1.23202	1228.54	614.270	10.2526	5.12631	76.6953	38.3476
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	50.1	1.23257	1229.09	615.774	10.2572	5.13886	76.7296	38.4415
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	50.2	1.23313	1229.64	617.279	10.2618	5.15142	76.7639	38.5355
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	50.3	1.23368	1230.19	618.785	10.2654	5.10399	76.7982	38.0295
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	50.4 50.5	1.23423	1230.74	620.295	10.2710	5 18920	76.8676	38,8181
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	51.0	1.20478	1231.30	629.370	10.2987	5.25232	77.0399	39.2903
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	51.5	1.24034	1236.83	636.967	10.3218	5.31573	77.2128	39.7646
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	52.0	1.24313	1239.62	644.602	10.3451	5.37944	77.3869	40.2412
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	52.5	1.24593	1242.41	652.265	10.3684	5.44339	77.5611	40.7196
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	53.0	1.24874	1245.21	659.961	10.3917	5.50762	77.7359	41.2001
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	53.5	1.25156	1248.02	007.090 675 159	10.4192 10.4997	5.57212 5.68600	77.9113 78 0874	41.0820 49 1679
55.0 1.26007 1256.51 691.080 10.4860 5.76732 78.4414 43.1428	54.0 54 K	1,20439	1200.84	683.250	10.4623	5.70197	78.2641	42.6539
	55.0	1,26007	1256.51	691.080	10.4860	5.76732	78.4414	43.1428

°Brix or % by wt. sucrose	Apparent specific gravity 20/20°C	Wt./liter in air at 20°C (g)	Sucrose/liter in aid (g)	Wt./gal in air at 20°C (lb.)	Sucrose/gal in air (lb.)	Wt./ft³ in air at 20°C (lb.)	Sucrose/ft³ in air (lb.)
55.5	1.26293	1259.36	698.944	10.5098	5 83995	78.6198	48 6887
56.0	1.26580	1262.22	706.843	10.5337	5 89886	78 7978	44 1969
56.5	1.26868	1265.09	714.775	10.5576	5 96506	78 0770	44 6990
57.0	1.27156	1267.97	722.742	10.5817	6 08155	70.5770	45 1104
57.5	1.27446	1270.86	730.744	10.6058	6.09833	70 8879	45 6190
58.0	1.27736	1273.75	738.775	10.6299	6 16534	79.5372	46 1909
58.5	1.28028	1276.64	746.834	10.6540	6 23260	70 6081	46 6984
59.0	1.28320	1279.58	754.952	10.6786	6 30035	70.8816	47 1901
59.5	1.28614	1282.51	763.093	10 7030	6 86899	90.0645	47.1301
60.0	1.28908	1285.44	771.264	10 7275	6 4 9 6 4 9	80.0045	47.0304
60.5	1.29203	1288.38	779, 470	10.7520	6 50496	80.4910	49 6607
61.0	1.29498	1291.33	787.711	10 7766	6 57878	90,6151	40.1759
61.5	1.29796	1294.30	795,994	10.8014	6 64986	80.0101	49.1754
62.0	1.30093	1297.26	804.301	10.8261	671918	80.0000	49.0949
62.5	1.30393	1300.25	812,656	10.8511	6 79101	91 1710	50.2105
63.0	1.30694	1303.25	821.047	10.8761	6 95104	01.1/19	20.7323
63.5	1.30994	1306.26	829.475	10.0701	6 09997	01.0092 91 5471	51.2905 E1 7994
64.0	1.31297	1309.27	837.933	10.9263	6 00986	01.0471	51.7044
64.5	1.31600	1312.29	846 427	10.9515	7 06974	01.7551	52.5105
64.8	1.31784	1314.12	851 549	10.9668	7.00574	01.9200	52.8407
64.9	1.31845	1314.73	853 260	10.0000	7.10045	04.0370	55.1005
65.0	1.31905	1815 88	854 964	10.0760	7.12070	82.0739	55.Z0/5
65.1	1.31966	1315 94	856 677	10.3703	7.13499	82.1134 99.1515	53.3131
65.2	1.32028	1316 55	858 390	10.0971	7.14920	82.1915	53.4800
66.0	1.32516	1321.42	872.137	11.0277	7.27830	82.1895 82.4936.	53.5876 54.4458

example, if one million gallons of single strength juice were desired at 11.8°Brix from 41.8°Brix concentrate, how much error in single strength °Brix would be incurred in 41.9°Brix concentrate were used?

Add 3 parts of water to 1 part of concentrate to make 1 million gallons of juice.

For 41.9°Brix concentrate,

Total solids =  $4.14437 \ge 250,000$ = 1,036,093 lb. pounds solids = 1,036,0931,000,000 = 1.03609 lb./gal  $^{\circ}$ Brix = 11.882 (calculated from Table 1).

For 41.8°Brix concentrate,

Total solids = 1,033,165 lb. pounds solids = 1.03317 lb./gal  $^{\circ}Brix = 11.850$  $^{\circ}$ Brix difference = 11.882-11.850 = 0.032.

One tenth °Brix error at 41.8°Brix will result in 0.032°Brix in reconstituted single strength juice.

Technically 0.1°Brix is an acceptable tolerance for Brix measurement. It should be recognized that even such a small tolerance will mean a great deal of cost to the citrus industry. For example, Nielsen reported retail orange juice (OJ) sales in the United States were 484, 295, and 24.9 million gallons single strength equivalent for frozen concentrate, chilled, and canned, respectively, in the 1981-82 season

(3). Using these figures, one tenth of one degree excess in Brix error in all products will translate into an estimated total seasonal solids cost of 5.3 million dollars at the assumed solids cost of \$1.22 per pound for the citrus juice trade.

Accurate measurement of °Brix is one of several factors affecting the total product yield. Other important factors include juice extracting and container filling. For most other practical purposes, the use of 4- to 5-digit existing Brix-pounds solids tables will result in errors less than 0.1% which is much less than potential errors in °Brix measurement using the best available technique. In view of the importance of <sup>o</sup>Brix measurement, the most accurate and reliable instrument should be used to ensure the correctness of °Brix measurement in citrus processing plants. Accurate determinations of juice yield and °Brix are necessary to ensure fairness to growers and processors.

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